National Park Service
U.S. Department of the Interior

Natural Resource Program Center

A Study Plan to Inventory Vascular Plants and Vertebrates: North Coast and Cascades Network (2001)

Natural Resource Technical Report NPS/NCCN/NRR—2009/089

ON THE COVER
Green Lake, North Cascades National Park
Photograph by: Ronald Holmes, NPS

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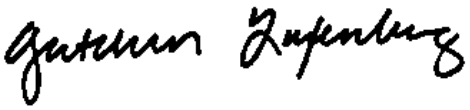
Approvals



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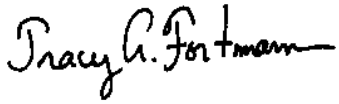

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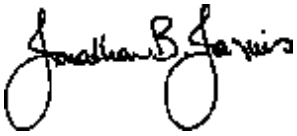

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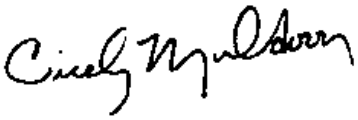

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Program Overview

Since its founding in 1916, the National Park Service has been charged with the task of preserving a remarkable wealth of forests, rivers, lakes, mountains, deserts, grasslands, and the plants and animals that live there. Within these landscapes are protected ecosystems that provide some of the finest natural laboratories on earth, unique recreational opportunities, and unparalleled opportunities to study and learn about natural processes and the effects of human activities on the resources around us. These landscapes also provide some of our greatest challenges in terms of protection. Declining air quality, introduction of non-native species, water pollution, incompatible uses of resources, and proximity to Puget Sound's growing urban development are among the challenges facing the ecosystems protected within the boundaries of the North Coast and Cascades Network.

The National Park Service's primary mission is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations. Currently, the Service is unable to attain its mission in many parks, owing to a serious lack of scientific information about the nature and condition of resources in those parks, especially biological resources. In 1992, the National Park Service's (NPS) Inventory and Monitoring Program identified a list of candidate elements and processes for initial inventory in all natural resource parks, proposed the establishment of prototype inventory and monitoring parks, and outlined national implementation guidelines. The National Parks Omnibus Management Act of 1998 recognized the need for good scientific information to manage parks. The act mandated a "program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources". Funding acquired through the Natural Resource Challenge (1999) provided the financial resources for National Park Service to initiate Species Inventory Programs focusing on vertebrates and vascular plants. The basic goal of this program is to provide park managers with comprehensive, scientifically-based information about the nature and status of selected biological resources occurring within park boundaries in a form that increases its accessibility and utility for making management decisions, for scientific research, and for educating the public. The inventories will also lay the groundwork necessary for park managers to develop effective monitoring programs and to formulate effective management strategies for resource management and protection.

Summary of Network Program

The North Coast and Cascade network includes: Ebey's Landing National Historical Reserve (EBLA), Fort Clatsop National Memorial (FOCL), Fort Vancouver National Historic Site (FOVA), North Cascades National Park Service Complex (NOCA), Mount Rainier National Park (MORA), Olympic National Park (OLYM), and San Juan National Historic Park (SAJH). Summaries of existing data revealed a wide range in quality and volume of existing information on species presence in the parks. The purpose of our study is to complete baseline inventories for vascular plants and vertebrates in network parks and to collect distributional data on selected species that is necessary for the development of a network monitoring strategy and design. Our

study plan is designed in conjunction with development of our network's long-term monitoring plan. Network funding for monitoring will start in FY01, offering both the opportunity and urgency to intensify inventory surveys to provide data necessary for developing long-term sampling methodologies.

Specific objectives of this study are:

1. Compile species lists for vascular plants and vertebrates that are verified at the 90% level for all network parks. We are placing emphasis on records less than 25 years old to describe current species status in the parks. We expect 90% verification for most taxa groups will be reached through searches of existing data including museum records of voucher specimens, previous studies, and park databases. Field surveys will be conducted on taxa groups for which voucher or written records are not available.

2. Compile data in databases that are easily accessible and useable by others for use in management, interpretation, research, education, and park operations. All data will be input into NPSpecies databases, park GIS databases, and curatorial databases in a manner consistent with master, web-based databases developed through the NPS Inventory and Monitoring program.

3. Conduct field surveys of selected species or groups of species to document distribution and abundance patterns. These data will be used to refine sampling protocols for long-term monitoring.

Network Description

The North Coast and Cascade network includes: Ebey's Landing National Historical Reserve (EBLA), Fort Clatsop National Memorial (FOCL), Fort Vancouver National Historic Site (FOVA), North Cascades National Park Service Complex (NOCA), Mount Rainier National Park (MORA), Olympic National Park (OLYM), and San Juan National Historic Park (SAJH). Fort Clatsop National Historic Park is located along the coast in northern Oregon and the remaining six park areas are located in Washington (Figure 1). Spatially, the seven parks are distributed across a diverse landscape and range of climatic conditions and they portray a wide range of ecological diversity.

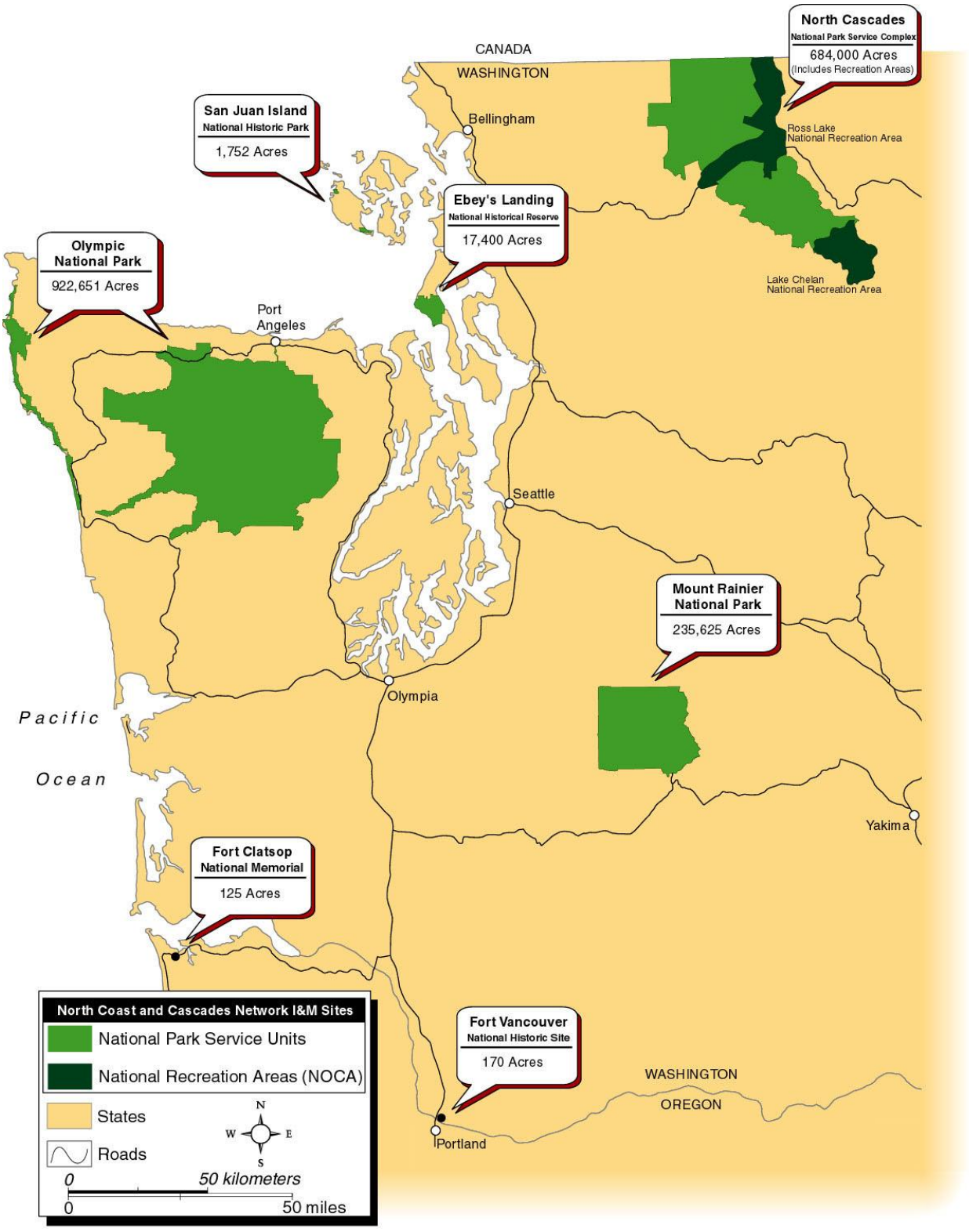


Figure 1. Map illustrating locations of parks within the North Coast and Cascades Network

Ebey's Landing National Historical Reserve

Ebey's Landing National Historical Reserve was established in 1978 to preserve and protect a rural community on Whidbey Island. The historical landscape of the reserve today looks much like it did a century ago – a mosaic of farms, forests, and century old buildings and homes. The site encompasses 25 square miles (17,400 acres) and includes federal, state, county, and private property (Figure 2). A Volunteer Trust Board administers the area to protect the cultural landscape and historic essence of the site. Ebey's Landing provides an unbroken historical record from nineteenth century exploration and settlement in Puget Sound to the present time, and commemorates:

-The first thorough exploration of Puget Sound by Captain Vancouver in 1792.
-Settlement of the area by Col. Isaac Ebey.
-Early active settlement during the years of the Donation Land Law (1850-1855).
-The growth since 1883 of the historic town of Coupeville.

To achieve the above purposes, congress required local government cooperators to formulate a comprehensive plan for the protection, preservation, and interpretation of the reserve. "The plan shall identify those areas or zones within the reserve which would most appropriately be devoted to: (A) public use and development, (B) historic and natural preservation, and (C) private use subject to appropriate local zoning ordinances designed to protect the historical rural setting."

The Comprehensive Plan (1980) provides guidelines for the above. Because of the unique status of the Reserve within the NPS, management objectives combine natural and cultural resources. Primary objectives are to: (1) identify and protect natural and cultural resources with a competent, professional management team; (2) provide public access in a manner that preserves and protects resources; (3) enhance public awareness of the significance of the resources; (4) establish and nurture strong resource management partnerships within the community and agencies; (5) establish sound and scholarly bases for decision making.

General Setting and Resources

The Reserve is located on central Whidbey Island, approximately 45 miles north of Seattle, at the extreme northern end of Puget Sound. To the east are the North Cascades; north and south are miles of islands, coves, and bays; southwest lie the Olympic Mountains. Whidbey Island varies from 1 to 10 miles in width and offers a rare combination of forests, prairies, and seascapes. A major force in the creation of this landscape was the Pleistocene glacial retreat about 13,000 years ago. The retreating ice left glacial moraines, gravel, sand, and clay. Natural forces continue to erode the beach bluffs and transport sand along the shores.

Outstanding natural features include miles of marine shoreline, 4,000 acre Penn Cove, three large native prairies, multiple glacial kettles, the island's best farmland, high seaside bluffs, low rolling hills, shallow brackish lakes, and a long, narrow, rugged beach along Admiralty Inlet.

The Reserve is located in the western hemlock forest zone of western Washington. The unique climate, rainshadow effect of the Olympic mountains (18.6" of rain annually), productive agricultural soils, maritime influence, and geologic features result in an unusual diversity of plant and animal species, communities, and habitats, including several small populations of the federally listed (threatened) *Castilleja levisecta* (Golden Indian Paintbrush). Native flora are very diverse, ranging from small, scattered stands of old-growth Douglas-fir forest, flat-leafed cactus, and miles of hedgerows to dense rhododendron thickets, significant salt marsh communities and a recently discovered intact acre of original, pristine prairie. Numerous populations of invasive exotic flora exist within the Reserve.

The rich marine resources attract over 140 species of migratory and resident birds. Marine mammals are commonly observed in the waters mentioned above. Little is known of reptile, amphibian, mammal, or invertebrate populations within the Reserve.

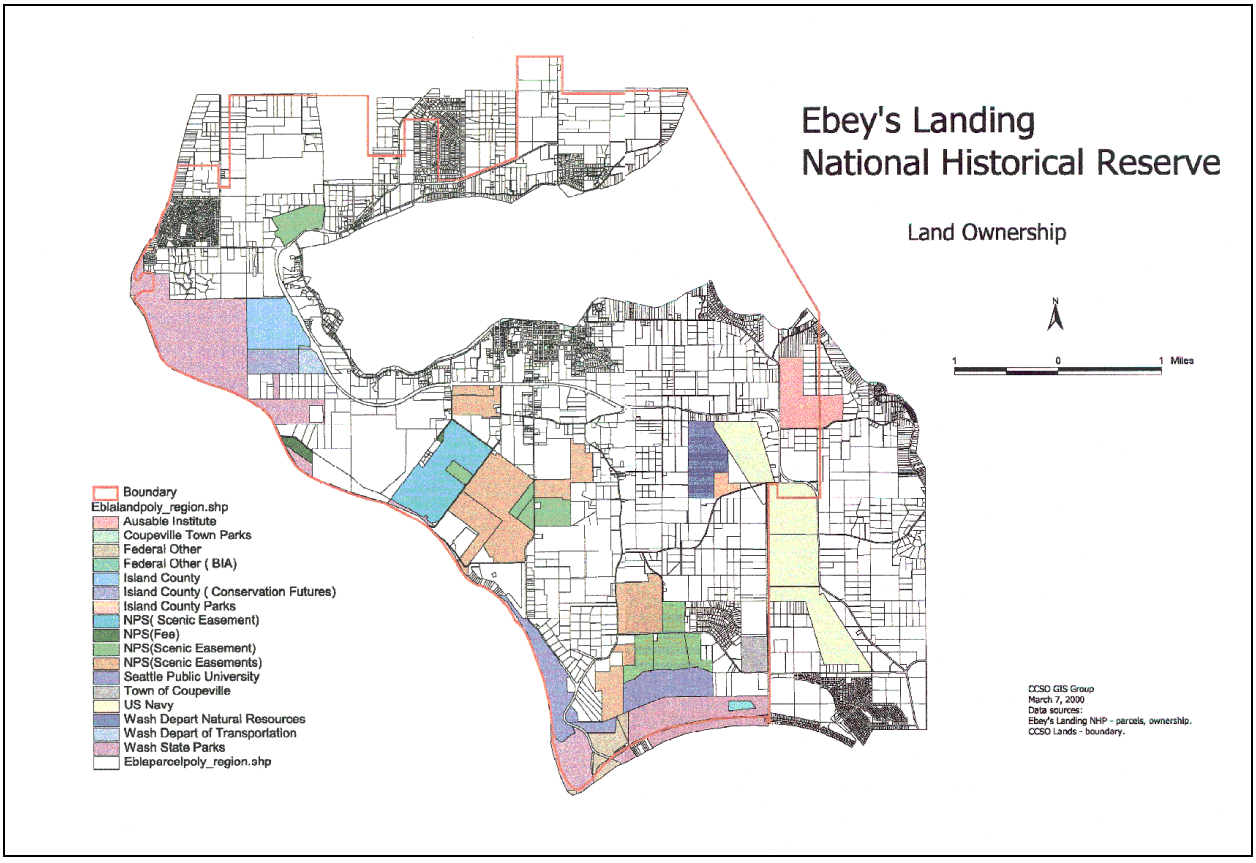


Figure 2. Ebey's Landing National Historical Reserve

Fort Clatsop National Memorial

Fort Clatsop National Memorial was established in 1958 to "commemorate the culmination and Winter encampment of the Lewis and Clark Expedition."

Primary resource management objectives are to: (1) proactively monitor the park's cultural and natural resources in order to mitigate potential impacts, (2) conduct continuing research to gather and analyze information necessary for managing the park's resources, (3) restore terrestrial, wetland and aquatic resources ecosystems and processes so they may operate essentially unimpaired, (4) restore altered natural resources and processes and cultural landscapes to a condition as close as possible to what they would be today had the resources or processes continued unimpaired, (5) protect threatened and endangered plant and animal species and reintroduce, where practical, those species eliminated or seriously reduced from the natural ecosystem, (6) obtain at least the Phase I inventory and monitoring standard as identified in NPS-75, the Inventory and Monitoring Guideline, (7) identify and evaluate all cultural resources within park boundaries for their significance and if determined eligible, nominate the properties to the National Register of Historic Places, (8) adjust park boundaries as required to preserve important park resources, to complete ecological units insofar as possible and/or to provide for more effective management, (9) permit only those types and levels of use or development that do not significantly impair park resources or values and provide only those types and levels of programs and activities that enhance visitor understanding and enjoyment of park resources, (10) work closely with various local and regional managers, other agencies and departments, tribal representatives, scientists, educators, land owners, organizations, businesses, interest groups and individuals in order to provide a more integrated approach to park management, (11) foster an awareness and appreciation among park visitors and neighbors of the significance of the park, its resources and processes, and the role the park plays within the region.

General Setting and Resources

Fort Clatsop National Memorial is located near the extreme northwest corner of Oregon and encompasses 125.2 acres in three disjunct units (Figure 3). Visitor services are located within the 108 acre larger unit on the west shore of the Lewis and Clark River and the 100 foot by 100 foot Salt Works Site unit situated within downtown Seaside, OR. The third unit of the park is a 17 acre parcel of land located along the east shore of the Lewis and Clark River opposite the main unit. The park is located within three miles of Astoria, the oldest American settlement west of the Rockies, with a current population of approximately 10,000.

The topography of the park varies from estuarine mudflats in the Lewis and Clark valley to steeper forested slopes and benches of the eastern toe-slope of Clatsop Ridge, the northern-most portion of the Oregon Coast Range. Elevation ranges from 6 feet to 60 feet. The park's climate is

characterized by relatively warm and dry conditions in the summer and fall and cool, wet conditions in the winter and spring. Rainfall averages approximately 70 inches per year.

Although small in size, Fort Clatsop contains diverse wildlife habitat and resources. Park ecosystems range from the estuarine mudflats and tidal marshes, to shrub and forested swamps and upland coniferous rainforest, dominated by Sitka spruce as large as 6 feet in diameter. Ten types of wetlands occur within the park in palustrine, estuarine and riverine systems, as identified by the National Wetland Inventory, and wetlands comprise approximately half the park acreage. Surface water consists of the tidally influenced Lewis and Clark River, low-gradient brackish sloughs, freshwater ponds and small freshwater streams and springs. Approximately 50 acres of the park is coniferous forest habitat, composed of approximately 20 acres of older forests and 30 acres of younger forests. Flora and fauna diversity within Fort Clatsop National Memorial are high, reflecting the park's habitat diversity, its moderate climate, its location along the Pacific flyway and its proximity to the Pacific Ocean.

The replica of the original Fort Clatsop was built in 1955 for the Lewis and Clark Sesquicentennial by local civic organizations. The fort is the nucleus for a variety of interpretive, educational and living history programs throughout the year. The entire park is listed on the National Register of Historic Places.

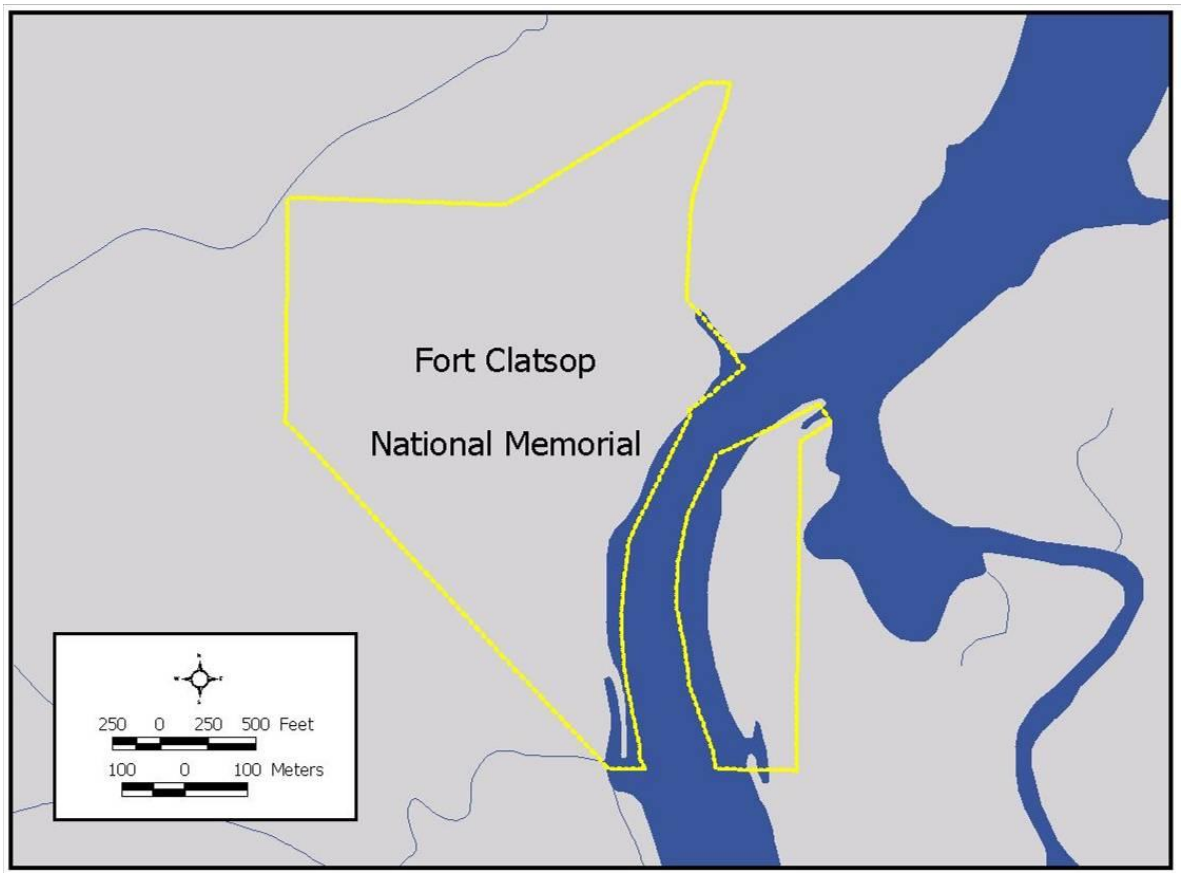
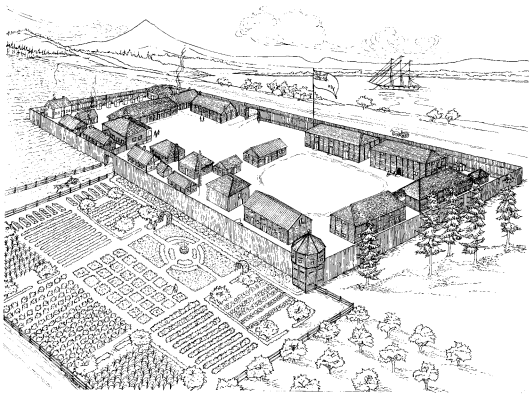


Figure 3. Fort Clatsop National Memorial

Fort Vancouver National Monument



Fort Vancouver was initially established as a National Monument in 1948 to protect and maintain "the site of the original Hudson's Bay stockade and sufficient surrounding land to preserve the historical features of the area" for the benefit of the people. The Department of the Interior's report on the same legislation concurred, stating that the lands so dedicated should fulfill "two essential requirements – the preservation of the historic stockade . . .and the preservation of the historic parade ground of the later United States Army post." Thus, the purpose is to maintain the site of this primary center of early economic, cultural, and military development in the Pacific Northwest and to interpret the important part played in our nation's westward expansion by the fur trade and other activities carried on at the fort. To further achieve this goal, Congress passed the act of June 30, 1961, enlarging the boundaries of Fort Vancouver and redesignating the monument a National Historic Site.

The site currently encompasses some 170 acres in a variety of conditions (Figure 4). The natural environment of the site has been heavily impacted over time by the Hudson's Bay Company and by development, primarily US Army, which moved into the area in 1849. As a result of these impacts, almost none of the site's historic natural environment remains. Today the site is comprised of: 62.9 acres of maintained historic landscapes with ornamental plantings and orchards, 83.3 acres of developed land (airport and railroads), and 23.8 acres of disturbed uplands and riparian areas. The uplands contain several aggressive exotic plant species and 9.3 acres of disturbed area in the Columbia River riparian corridor.

In order to properly preserve and interpret the site's full story, park management desires to re-establish a portion of the site's natural area to show the landscape as it was upon arrival of Euro-Americans in the early 19th century. This mandate of natural environment preservation and establishment is supported by the park's enabling legislation which refers to "sufficient surrounding land" (cultural and natural), as well as the 1978 Master Plan and 1993 Cultural Landscape Report. Current planning efforts to complete a new General Management Plan (scheduled for public release in early fall 2001) also are supportive of the reestablishment of a vestige of the areas natural environment, consisting of approximately 10 acres. The natural environment played a key role in the culture of native people and in this site being the place where the Fort was originally established.

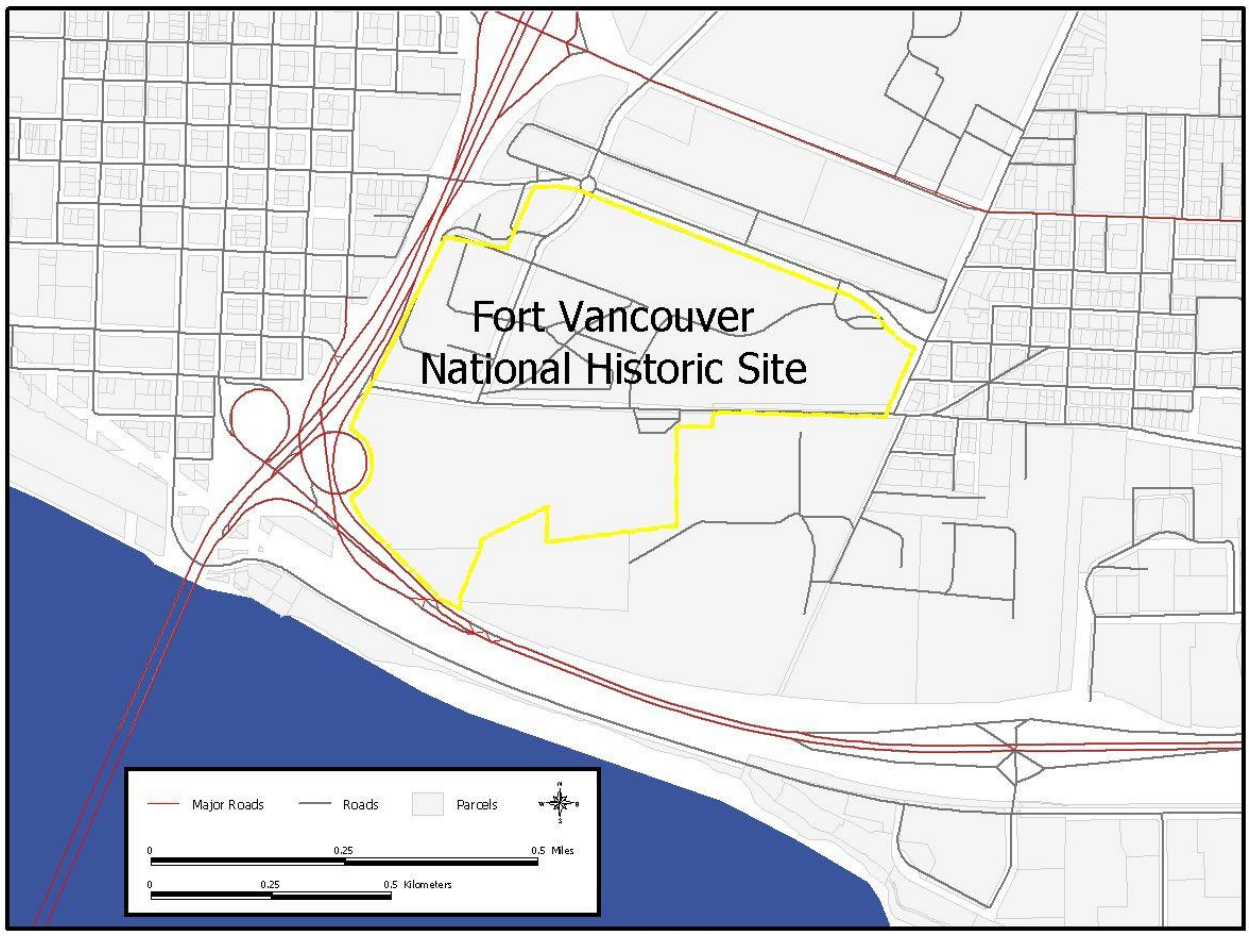


Figure 4. Fort Vancouver National Historic Site

Mount Rainier National Park

Mount Rainier National Park encompasses 235,625 acres on the west-side of the Cascade Range, and is located about 100 kilometers (50 miles) southeast of the Seattle-Tacoma metropolitan area (Figure 5). The park was established in 1899 to *"…provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders…and their retention in their natural condition…grant parcels of ground at such places shall require the erection of buildings for the accommodation of visitors…provide against the wanton destruction of the fish and game found in the park"* (Mount Rainier National Park Act 1899). As directed by the NPS Organic Act, the Redwood Act for Expansion and its enabling legislation, the major activities conducted by Mount Rainier National Park are the protection and preservation of natural and cultural resources and the provision for use of the park by visitors. Mount Rainier National Park is approximately 97 percent wilderness and 3 percent National Historic Landmark District and receives approximately 2 million visitors per year.

At 14,411 feet, Mount Rainier is the most prominent peak in the Cascade Range. It dominates the landscape of a large part of western Washington State. The mountain stands nearly three miles higher than the lowlands to the west and one and one-half miles higher than the adjacent mountains. It is an active volcano that last erupted approximately 150 years ago.

The park is part of a complex ecosystem. Vegetation is diverse, reflecting the varied climatic and environmental conditions encountered across the park's 12,800-feet elevation gradient. Approximately 58 percent of the park is forested, 23 percent is subalpine parkland, and the remainder is alpine, half of which is vegetated and the other half consists of permanent snow and ice. Forest ages range from less than 100 years old on burned areas and moraines left by receding glaciers to old-growth stands 1,000 or more years. Some alpine heather communities have persisted in the park for up to 10,000 years.

Species known or thought to occur in the park include more than 800 vascular plants, 159 birds, 63 mammals, 16 amphibians, 5 reptiles, and 18 native fishes. The park contains 26 named glaciers across 9 major watersheds, with 382 lakes and 470 rivers and streams and over 3,000 acres of other wetland types. Of these vertebrates, there are 4 federally listed threatened or endangered species known to occur in the park, including 3 birds and 1 fish. Four other species historically occurred in the park, but their present status is unknown including: gray wolf, grizzly bear, Canada lynx, and Chinook salmon.

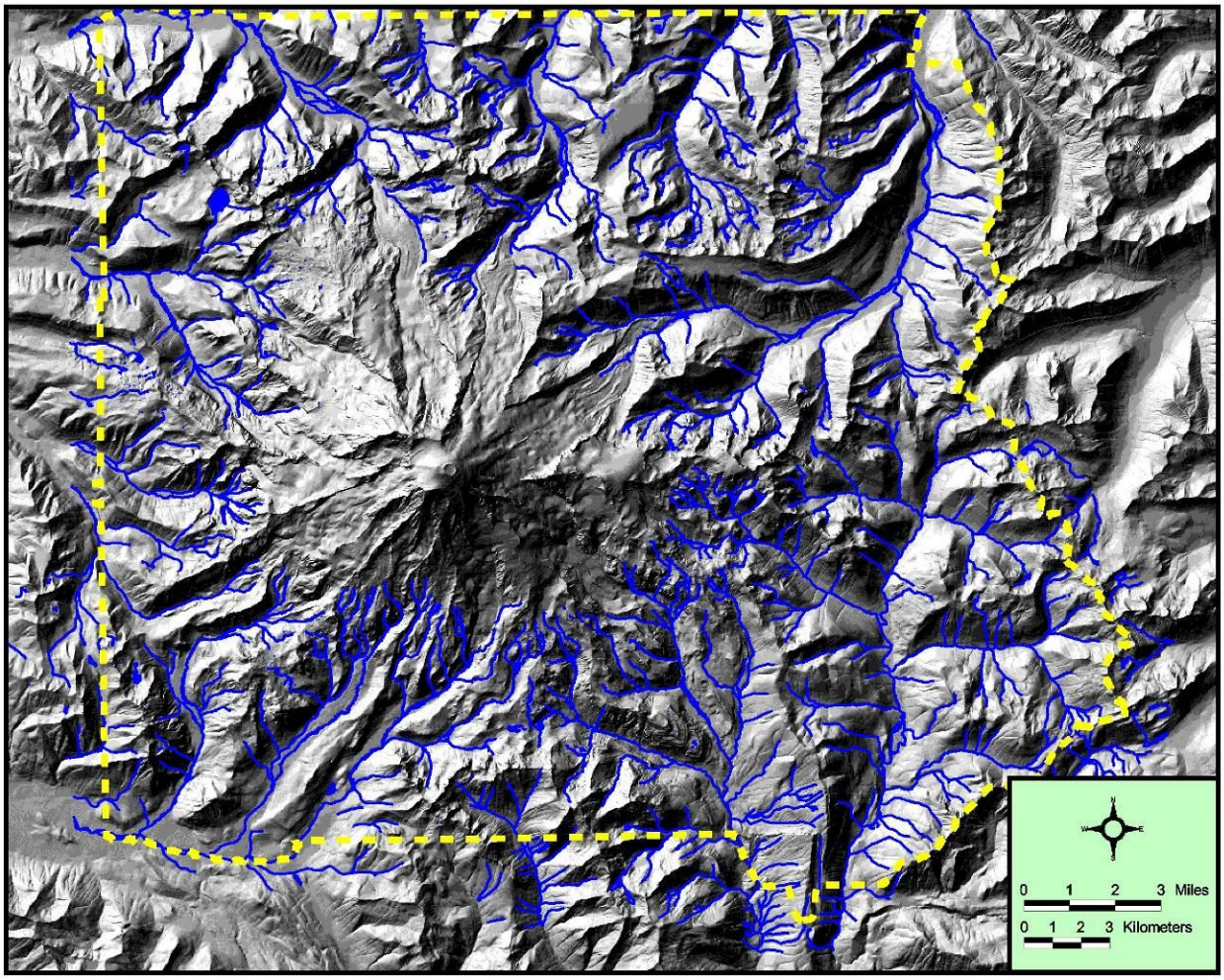


Figure 5. Mount Rainier National Park

North Cascades National Park Service Complex

North Cascades NPS Complex (North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area) covers 684,238 acres of the Cascade Range from the Canadian border south approximately 50 miles to the head of Lake Chelan (Figure 6). The Stephen Mather Wilderness encompasses approximately 93% of the Complex.

The topography, geology, and hydrology of the Complex are extremely varied. Local relief is approximately 8,800 feet, with the lowest point at 400 feet along the Skagit River at the Complex's west boundary and several peaks over 9,000 feet. There are approximately 320 active glaciers in the Complex. The major watersheds are the Skagit River, and the Stehekin River. The Skagit River is the largest watershed in Puget Sound and is impounded by three Seattle City Light hydroelectric dams. The bedrock geology and geologic history is complex because of the location along the tectonically active western edge of the North American lithospheric plate. The accretion, metamorphism, and movement of exotic terrains and the intrusion of igneous and associated extrusive rocks have punctuated the area's geologic history.

The great variety of plant species is a result of the extreme variation in elevations combined with the presence of ecosystems representing both the east and west side of the Cascades Range. Over 1,627 vascular plant species had been identified, however only 881 of these were collected for voucher specimens.

The variety of habitats in the park and recreation area supports over 320 vertebrate species. There are approximately 75 mammal species in 20 families and approximately 21 species of reptiles and amphibians representing at least four orders. The avian fauna of the Complex is comprised of roughly 200 species in 38 families. At least 28 species of fish are known to be present. Recent surveys have documented over 500 terrestrial invertebrate taxa and approximately 250 aquatic invertebrate taxa.

The rugged landscape of the North Cascades has been occupied and modified by human populations for thousands of years. Four Native American groups occupied the region: the Upper Skagit who utilized resources along the Skagit River and its tributaries up to the gorge at Newhalem; the Chilliwack who used the upper reach of the Chilliwack River; the Lower Thompson who occupied the upper reaches of the Skagit River in the area now covered by Ross Lake; and the Chelan in the southeast.

Early explorers and the Hudson Bay Company were among the first Europeans to visit the area. Settlement patterns focused on the Skagit River on the west and the Stehekin River on the east. Development included settlement by homesteaders in the valley bottoms and miners.

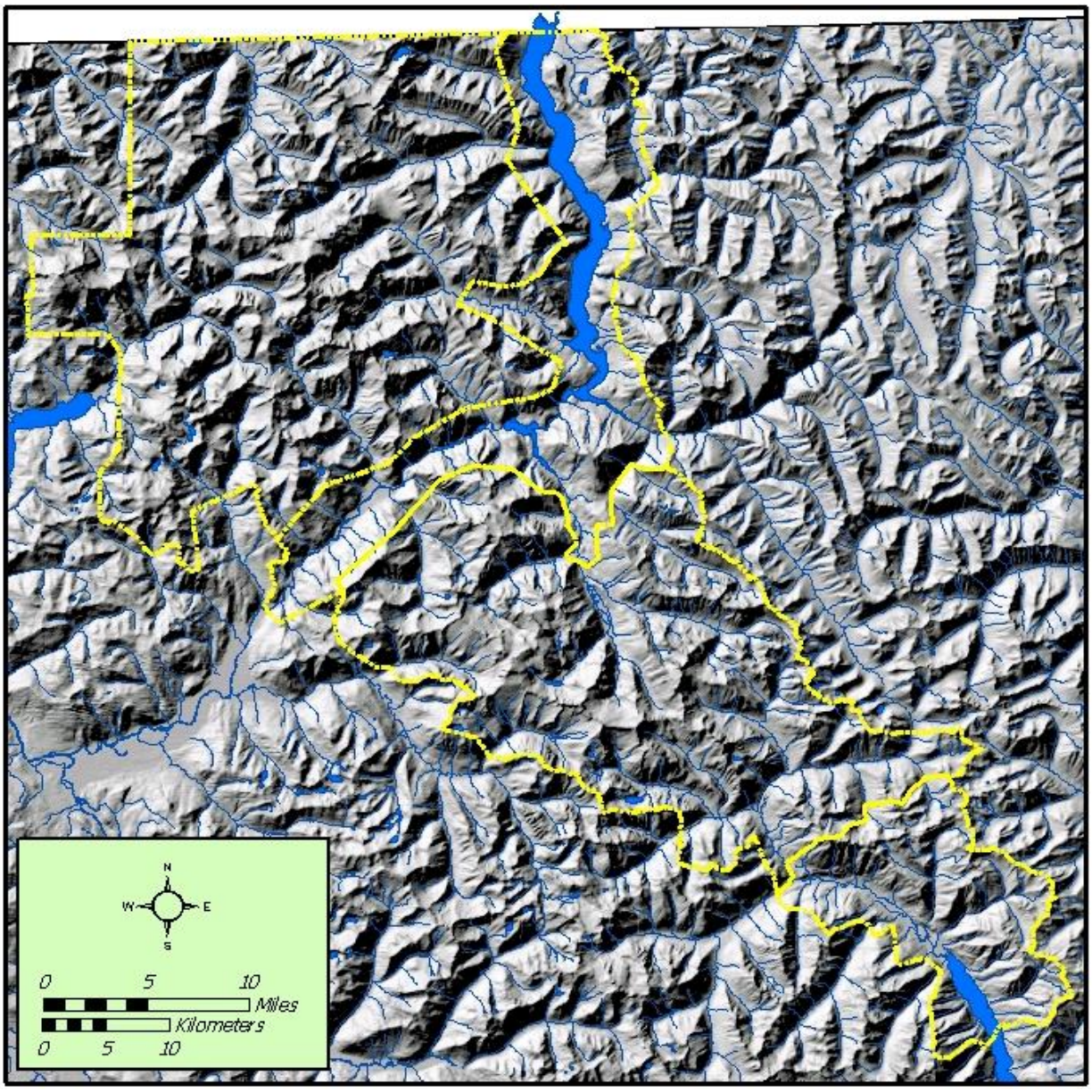


Figure 6. North Cascades National Park Service Complex

Olympic National Park

Olympic National Park was established in 1938 to "preserve for the benefit, use and enjoyment of the people, the finest sample of primeval forests of Sitka spruce, western hemlock, Douglas fir, and western red cedar in the entire United States; to provide suitable winter range and permanent protection for the herds of native Roosevelt elk and other wildlife indigenous to the area; to conserve and render available to the people, for recreational use, this outstanding mountainous country, containing numerous glaciers and perpetual snow fields, and a portion of the surrounding verdant forests together with a narrow strip along the beautiful Washington coast."

Primary park objectives are to: (1) protect the park's natural and cultural resources and ensure professional management of these resources, (2) provide public access in a manner compatible with preserving park resources, (3) enhance visitor and community understanding and conservation of park resources, (4) work closely with other agencies and the community to effectively solve resource management problems, (5) establish a sound, scholarly basis for resource management decisions, (6) create and maintain a highly professional organization and workforce.

General Setting and Resources

Olympic National Park encompasses 922,651 acres (over 1,400 square miles) in the center of Washington's Olympic Peninsula and along a 60-mile strip of wilderness coastline on the Pacific Ocean (Figure 7). The park is located less than 116 kilometers (72 miles) west/northwest of the Seattle-Tacoma area (36 miles as the crow flies; Figure 1). The park receives over 5 million visits per year, most from the state of Washington. Over 96% of the park is designated as wilderness.

From sea level, the park rises to almost 8000 feet at Mount Olympus in less than 40 miles. The Olympic Mountains intercept moisture-laden Pacific winds, resulting in a rainshadow effect more pronounced than any other in North America. Olympic National Park is the wettest spot in the conterminous United States. The west slopes of Mount Olympus receive about 200 inches of precipitation per year, while less than 34 miles to the east, precipitation is under 20 inches per year.

The park's biotic diversity mirrors its climatic diversity. Park ecosystems range from the rich intertidal zone, to rainforests, montane forests, alpine meadows, and glaciers. Temperate rainforests blanket the western slopes of the mountains, while alpine tundra conditions prevail in the dry, northeast section of the park. Along this gradient, Sitka spruce, Western red cedar, and Western hemlock yield to subalpine fir, white pine, and lodgepole pine.

Although they occur as a separate, higher and more rugged mountain massif, geologically, the Olympic Mountains are closely related to the Coast Range of Oregon. The predominant rock types of the Olympics are sandstone, shale, and basalt. Most rocks of the Olympic Mountains were formed on the bed of the Pacific Ocean, and later uplifted to form a "disorganized, circular array of jagged peaks" (Tabor, 1987). These mountains formed during a separate uplift event, rather than as part of the long coastal mountain chain. Eleven major rivers radiate from the mountainous core of the park and 260 glaciers and over 400 lakes and wetlands lie within these watersheds.

During glacial periods of the Pleistocene, the Olympic Mountains were cut off from the continent. This island-like isolation fostered high levels of endemism among plant and animal communities of the Peninsula. There are thirty five (35) endemic forms of plants and animals currently recognized on the Olympic Peninsula, including 15 endemic plants, 1 amphibian, 3 fish, and 5 mammals. Largely due to habitat alterations (or harvest activities) outside park boundaries, there are also 10 federally listed threatened or endangered species within the park, including 5 birds, 4 fish, and 1 insect species. At least one species, the gray wolf, is known to be extirpated. Another species, the fisher, is also suspected to be extinct within the park.

The park is recognized as both a World Heritage Site, and an International Biosphere Reserve. In its review of the park's nomination as a world heritage site, the International Union for the Conservation of Nature concluded that: "Olympic National Park is the best natural area in the entire Pacific Northwest, with a spectacular coastline, scenic lakes, majestic mountains and glaciers, and magnificent temperate rain forests; these are outstanding examples of on-going evolution and superlative natural phenomena. It is unmatched in the world."

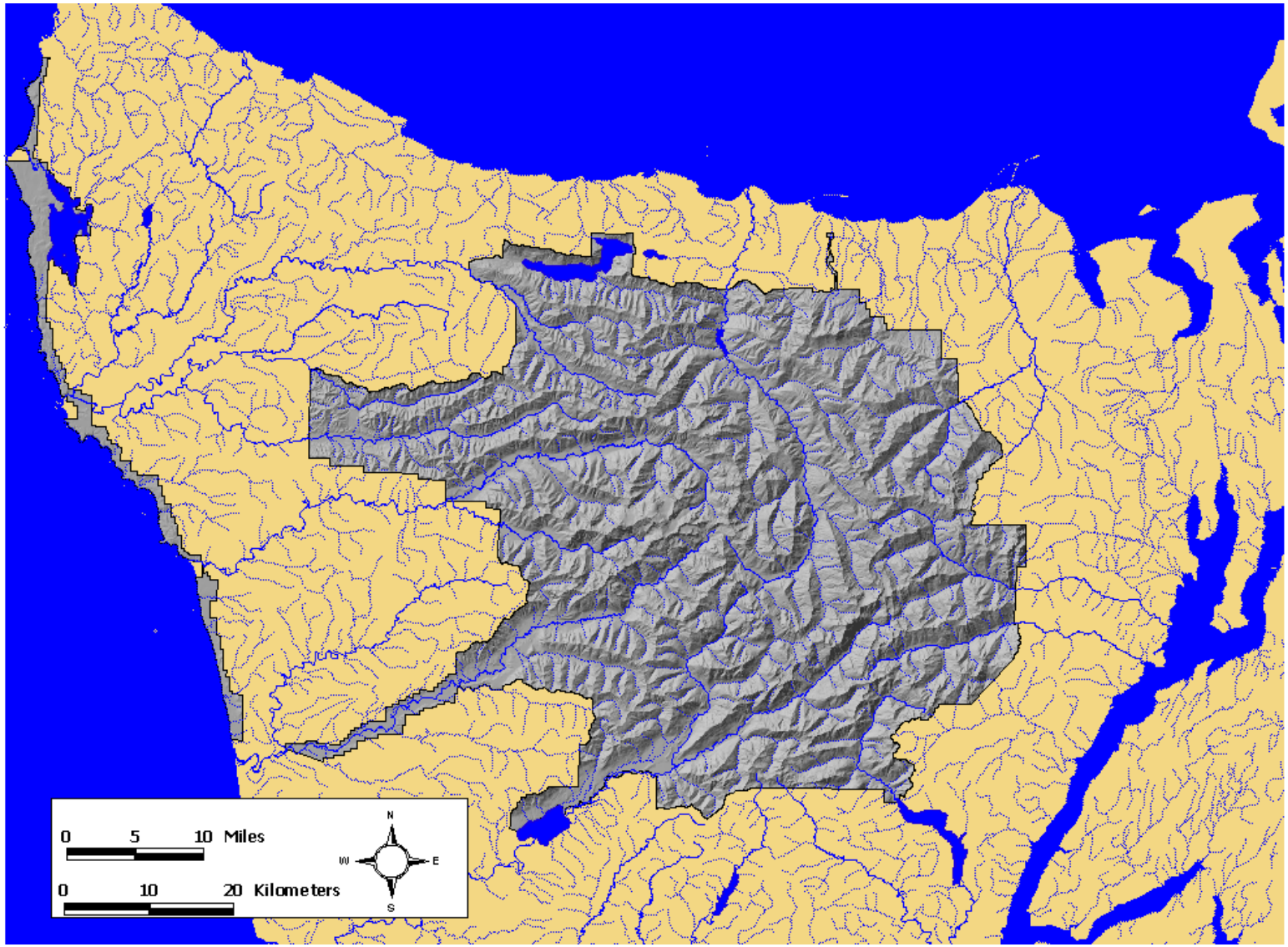
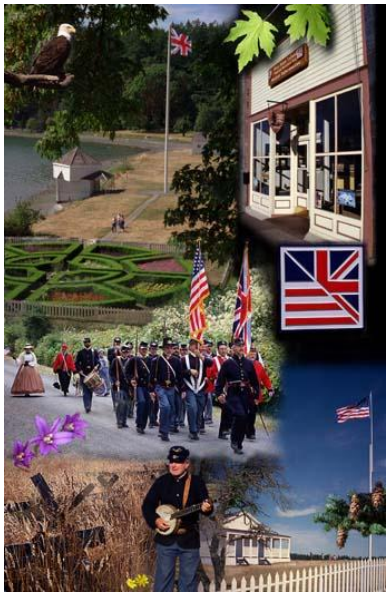


Figure 7. Olympic National Park

San Juan Island National Historical Park



San Juan Island National Historical Park, established in 1966, comprises 1,752 acres, and preserves the sites of the American and English camps on the island (Figure 8). The park commemorates the historic events that occurred from 1853 to 1871 on the island in connection with the final settlement of the Oregon Territory boundary dispute, including the Pig War of 1859. The park is the largest public open space on San Juan Island. In addition to the historical buildings and features at both camps, the park contains important prehistoric Indian sites.

Natural resources within the park are varied and include: 6.1 miles of shoreline and intertidal habitat; 92 acres of wetlands, including 3 marine lagoons; 900 acres of grassland, which supports varied raptor and songbird populations; a slightly smaller acreage of largely second-growth fir, cedar and maple forests and Garry oak woodland. Impacts from logging, grazing and cultivation are evident at both camps, but small pockets of old growth forest remain. Exotics abound, especially at American Camp.

Park-specific objectives

The spread and distribution of exotic plants and animals are a major concern. Exotic plant invasions are encouraged by the burrowing activities of exotic European rabbits. The elimination of ground-nesting birds is linked to the activities of feral cats and introduced red foxes. Inventories are needed to determine the distribution of exotic plants and animals. Information is also needed on vectors of spread of exotics so that preventative measures can be initiated.

As the largest natural area on the island, the park is subject to ever-increasing pressures from near-park development, increasing visitation, and different kinds of recreational uses. Inventories are needed to determine if listed and sensitive plant and animal populations are present that might be impacted by these activities. It is not known whether the park contains any listed plant species, such as the golden paintbrush, that have been documented elsewhere on the island. Habitat for the listed marbled murrelet habitat has been located in the park, but no surveys have been conducted to determine they are present. No other listed bird or mammal species are thought to be present in park. Management has also identified a need for a park plant checklist for visitors that could be developed as a product of a completed plant inventory. Little is known about the reptile and amphibian populations in the park or whether there are any listed species present. Park-specific inventories need to be conducted to fill in this information gap.

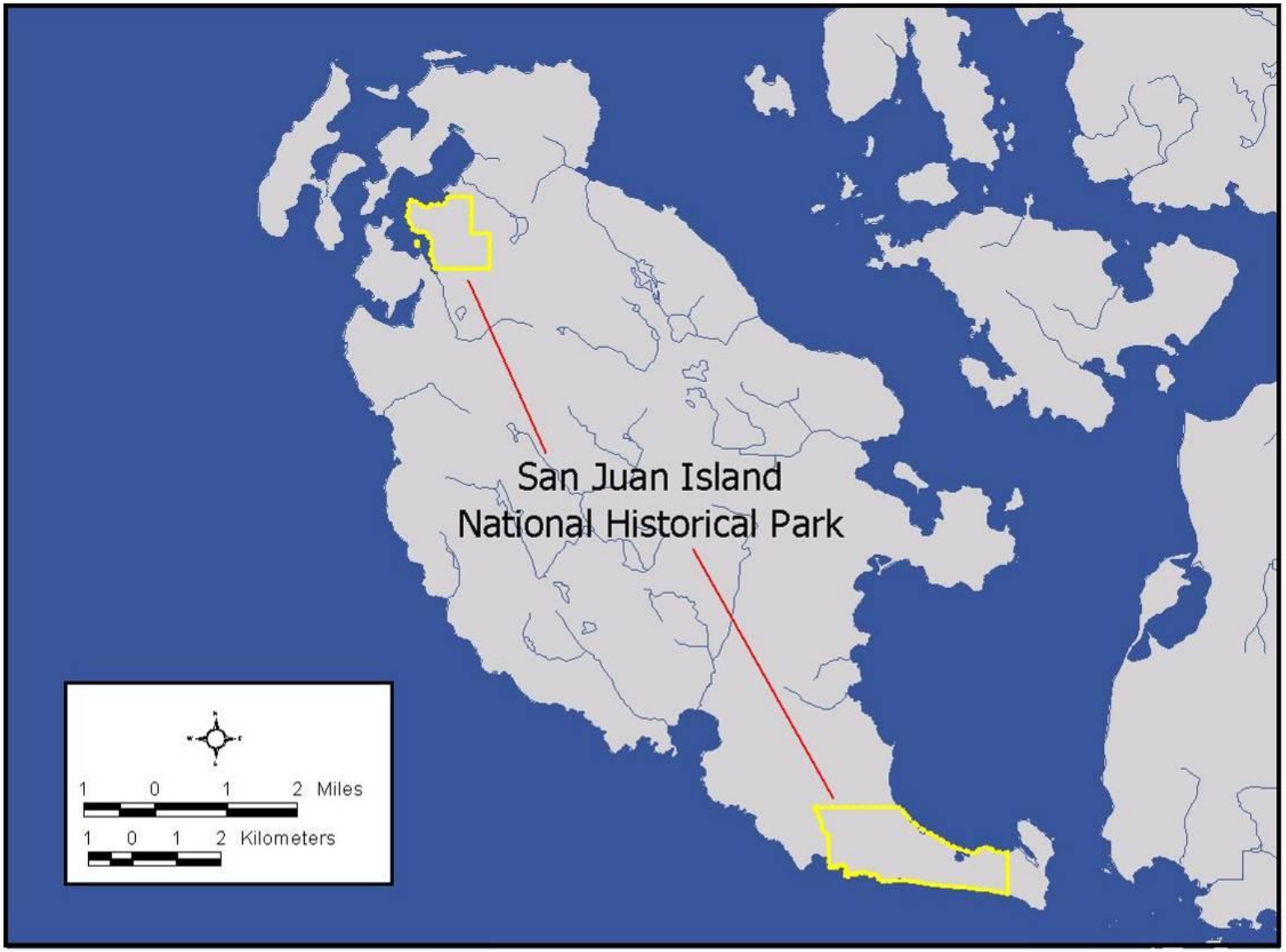


Figure 8. San Juan Island National Historic Park

Summary of Existing Data and Work Accomplished in FY00

Organizational Structure and Work Accomplishments

We have organized ourselves into a steering committee, core committee, NPS support team and collaborators (Appendices 1,2,3). The steering committee is composed of Park Superintendents, Chief of Resources from three parks, the Regional I&M Coordinator, and a Science Advisor as chairperson. The steering committee will make final decisions on proposed work, funding allocation, and contracting. The core committee will identify regional and park issues, propose work priorities, and develop methods for all work elements. The core committee will be assisted in their tasks by a support group of National Park Service technical experts and collaborators from USGS/BRD, USFS scientists, university scientists, and other scientists familiar with the natural resources of the seven parks.

The core committee first met in October, 1999 to develop our organizational structure, develop and overview of where we thought we were in terms of inventories, and develop our work plan. Following completion and submission of our pre-proposal, we hired biological technicians to collect data, began data collection and input, and began working within our taxa groups on development of work plans. Since our network contained two prototype parks that had completed vital signs scoping sessions and some initial protocol development, we decided to build on the results from their workshops and meet with technical experts contacted through their work sessions rather than hold a new series of scoping sessions. A "whitepaper" summarizing the species inventory program and our status within the network was mailed with a letter to all scientists identified as potential collaborators (Appendix 3) to request their involvement in our plan development. We also sent letters of inquiry to local museums, identified by Regional Curator Kent Bush, which might contain collections from network parks (Appendix 4). Meetings among taxa groups and the core group were scheduled throughout the year to continue development of the study plan and guide on-going data collection efforts.

We organized ourselves into three taxa groups: birds & mammals, herps and fish, and vascular plants. Herps were separated into amphibians and reptiles based on work responsibilities of resource specialists within our parks. Generally, reptiles, birds and mammals are the responsibility of wildlife biologists while fish and amphibians are handled by aquatic or fish biologists. The first step in our data collection was to develop master lists for all taxa groups. For some taxa groups (amphibians, reptiles) this was relatively easy. However, others were either not available or required peer review and moderate revision. For example, complete vascular plants lists were only readily available for Mount Rainier National Park and Fort Clatsop National Memorial. Although Olympic and North Cascades had working lists, they were developed on an ecosystem level that included broad geographic zones surrounding each park and habitats that were not represented within the park boundaries. No fish lists were available for San Juan Island NHP or Fort Vancouver NHS and there were questions as to whether habitat was even available within park boundaries. Boundary and ecological questions were resolved through discussions with park management, knowledgeable scientists, and review of enabling legislation.

Once master lists were developed, we began data collection. All data from park collections was entered into the voucher components if they had not been received from the NPS Inventory & Monitoring Division. In our pre-proposal, we had stated that our priority would be to compile species occurrence records less than 25 years old so that we would be able to evaluate current park verification status. However, older data has been included for some of the older parks, due to the volume of data, especially vouchers, greater than 70 years old. After we input park collection records into NPSpecies databases, our priorities for data collection were: location of other voucher specimens, scientific studies, and observational records. Data collection focused on collection of data from voucher specimens since they were the most reliable forms of verification. Input of verifications from scientific studies and observations were conducted based on availability of voucher data and logistics. Updates to NRBIB were co-ordinated with Marilyn Ostergren of the Seattle Support Office and Gay Hunter at Olympic National Park and enabled us to more rapidly update this database utilizing funds from other sources. Although we had planned to enter data into the Dataset Catalog, this was not started because design work was still being conducted on this database by the I&M group. Additionally, Geo-referenced data were entered at Mount Rainier National Park through collaboration with a GIS funded project ($10,000 - Wildlife/Habitat Relationships). Data entered into NPSpecies databases is summarized in Table 1.

Simultaneous with data collection, each of the three taxa groups began development of work plans. Based on initial estimates of the verification level of species lists, groups planned work to reach the 90% level. Additional work tasks were identified based on park resource specialists' knowledge of availability of data, current and past resource studies, results of Vital Signs workshops at Olympic and North Cascades, and identification of management issues in each park. Once work elements were identified, consultations with technical experts began for clarification of issues and protocol development.

Table 1. Records entered into NPSpecies Databases.

Park	Category	Number of Records Input into NPSpecies				
		Park Vouchers	Scientific Studies	Observation Cards	NRBIB Entries	Georeferenced Records
EBLA	Birds	---	---	---		
	Mammals	---	---	---		
	Amphibians	---	---	---		
	Reptiles	---	---	---		
	Fish	---	---	---		
	Vascular Plants	---	251	---		
FOCL	Birds	14	333	135		
	Mammals	204	50	36		
	Amphibians	35	6	30		
	Reptiles	2	3	4		
	Fish	2	79	0		
	Vascular Plants	291	335	2		
FOVA	Birds	---	139	---		
	Mammals	---	33	---		
	Amphibians	---	2	---		
	Reptiles	---	4	---		
	Fish	---	27	---		
	Vascular Plants	---	56	---		
MORA	Birds	45	171	---		
	Mammals	1026	1252	---		Total for MORA = 7000
	Amphibians	14	13	13		
	Reptiles	0	9	---		
	Fish	4	9	1		
	Vascular Plants	1026	1252	---		
NOCA	Birds	25	620	---		
	Mammals	427	70	2		
	Amphibians	56	25	2		
	Reptiles	5	8	2		
	Fish	144	7	---		
	Vascular Plants	2986	1548	---		
OLYM	Birds	61	---	---		
	Mammals	125	---	---	1503 records updated in FY2000	
	Amphibians	14	---	---		
	Reptiles	5	---	---		
	Fish	30	---	---		
	Vascular Plants	3329	82	---		454
SAJH	Birds	---	56	---		
	Mammals	---	5	---		
	Amphibians	2	2	---		
	Reptiles	---	---	---		
	Fish	---	---	---		
	Vascular Plants	4	181	---		

Status of Inventories

The status of current inventories is summarized in Table 2. Data is organized by park and taxa group. Number of taxa expected indicates the number of species listed on the master list. If a master list has not been compiled for a given group the superscript i indicates the list is incomplete. Verification level estimates the level for a taxa group considering all sources and is shaded in gray if it is below 90%. The primary source of verification estimates the "highest" or most reliable source of the verification. If one species is represent by all three levels of verification, it will only be listed in the voucher column because this the most reliable form of identification. The absence of estimates in any verification column indicates that inventory of that level of data has not yet been initiated (e.g. OLYM has only surveyed voucher specimens has not started working on scientific studies or observational data). While the focus was on data less than 25 years old, the verification estimates include all data collected. Verification levels that accurately describe present species occurrences are likely to be less than those figures given. This is because for older parks, data is included for records documenting historical species occurrences that may no longer exist in the park. GIS data layers were also inventoried for all parks and are summarized in Table 3.

Table 2. Status of Inventories.

Park	Category	Number of Taxa Expected	Verification Level - %	Primary[1] Source of Verification - % (#)		
				Vouchers	Scientific Study	Observations
EBLA	Birds	148[i]				
	Mammals					
	Amphibians	12	0%			
	Reptiles					
	Fish					
	Vascular Plants	182[i]			(182)	
FOCL	Birds	118	51%	6% (7)	45% (53)	
	Mammals	44	75%	61% (27)	2% (1)	11% (5)
	Amphibians	15	26%	26% (4)		
	Reptiles	2	100%	100% (2)		
	Fish	22	9%	9% (2)		
	Vascular Plants	246	90%	86%(211)	4% (9)	1%(2)
FOVA	Birds	139[i]	26%		26% (36)	
	Mammals	35[i]	20%		20%(7)	
	Amphibians	4	0	0	0	0
	Reptiles	4[i]	0	0	0	0
	Fish	No habitat				
	Vascular Plants	60[i]			(53)	
MORA	Birds	159	83%	59%(94)	13% (21)	11% (17)
	Mammals	63	90%	81%(51)	6%(4)	3%(2)
	Amphibians	15	86%	86%(13)	0% (0)	0% (0)
	Reptiles	5	80%	80% (4)	0% (0)	0% (0)
	Fish	18	55%	22% (4)	33%(6)	0% (0)
	Vascular Plants	900	89%			
NOCA	Birds	223	79%	10% (23)	69% (153)	
	Mammals	80	64%	48%(38)	15%(12)	1%(1)
	Amphibians	12	100%	58% (7)	33% (4)	15% (2)
	Reptiles	9	89%	33% (3)	56% (5)	11% (1)
	Fish	28	86%	61(17)	25%(7)	
	Vascular Plants	1,627	67%	54 %(881)	13% (218)	
OLYM	Birds	289	30%	30 %(87)		
	Mammals	77	49%	49%(38)		
	Amphibians	14	100%	100 %(14)		
	Reptiles	6	50%	50% (3)		
	Fish	52	38%	38% (20)		
	Vascular Plants	1,187	70%	70%(828)		
SAJH	Birds	151	37%		37(56)	
	Mammals	6[i]			(4)	
	Amphibians	10	20%	10%(1)	10%(2)	
	Reptiles	4				
	Fish					
	Vascular Plants	648	26%	0.5%(3)	25% (164)	

[1] primary indicates the most reliable source of verification, e.g. if a species has both voucher and observational verification, it would only be tallied in the voucher column

[i] indicates an incomplete master list

Table 3. Available GIS layers for North Coast and Cascades Network parks.

GIS Layer	EBLA	FOCL	FOVA	NOCA	MORA	OLYM	SAJH
Boundary	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DOQQ	Yes	Yes	Yes	Yes	Yes	Yes	Yes[1]
DRG	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Elevation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exotic Plants				In Work	Partial	Partial	
Fire History				Yes	Yes	Yes	
Fuels						Yes	In Work
Geology (Bedrock)				Partial	Yes	Yes	
Geology (Surficial)					Yes		
Hydrography	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hypsography	In Work	Yes	Yes	In Work	In Work	In Work	Yes
Landforms				In Work	Yes	Yes	
Parcels				Partial		In Work	
Precipitation				Yes		Yes	
Roads	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soils	Yes	Yes	Yes	Partial	In Work	Yes	
T & E Species				Partial	Partial	Partial	
Trails	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vegetation (Canopy Closure)				Yes[2]	Yes[2]	Yes[2]	
Vegetation (Size Classes)				Yes[2]	Yes[2]	Yes[2]	
Vegetation (Species)				Yes[2]	Yes[2]	Yes[2]	In Work[3]
Watersheds	Yes			Yes	Yes	Yes	
Wetlands (NWI)	Yes	Yes	Yes	Yes[4]	Yes	Yes	Yes[4]

1) Color DOQ
2) Landsat-Based
3) Photo-Based
4) Additional Wetland Mapping Available

Priorities for Biological Inventories

Selection of Work Element Priorities

Work elements and priorities were developed after review of the current status of inventory verifications, review of data sources inventoried, and identification of species or suites of species that may be the focus of long-term monitoring programs (Table 4). Highest priority was given to any taxa group that was not verified at the 90% level. Two methods of verification were always considered to attain the 90% verification level: inventories of existing data and field surveys. If inventories of existing data have not been completed, this is generally our first choice. For example, fish lists are currently verified at the 41% in Olympic National Park based only on voucher specimens. However, we know that fish biologist John Meyer has databases that verify in excess of 90% of all fish species expected to occur in the park. Since data inventories have only focused on voucher specimens in Olympic, we propose to attain 90% verification by cataloguing John's data in the NPSpecies databases. In contrast, Mount Rainier National Park's fish list is verified at 55%, but all existing scientific studies, observations, and vouchers have been inventoried. In this case, the only method of reaching 90% verification is through field surveys of major streams. Each taxa group was reviewed in this manner to identify work elements to reach 90%verification.

Two other considerations weighed heavily in the design of our work plan: accessibility of collection data and integration of surveys with long-term monitoring plans. Accessibility of museum collections was important in choosing the methods to reach 90% verification. When we contacted local museums for potential park collections, we also asked if their collection inventories were electronically available. Collections such as the fish at the University of Washington or mammals at the Burke Museum were relatively easy for us to query and copy. However, many herbaria contacted are not computerized and extremely large. Inventories of these collections are so time consuming that we question the cost-effectiveness of our surveys. For example, the northwest collection of plants in the Botany Department at the University of Washington has 180,000 specimens that are stored by family and not computerized. In order to inventory this collection, one must look at every individual specimen. We decided to only look for species that were on our master list but had no verification. We realized that we would be overlooking distributional and historical data on species already verified, but even with this reduced list, work was very slow with limited "hits" on park specimens. Due to our limited success with these inventories, we have decided to conservatively continue with these focused inventories. If a taxa group feels field surveys would be more cost-effective, that is our preferred inventory method.

Integration of inventories with long-term monitoring protocol development was a very important consideration in our selection of species for abundance and distribution surveys. Our network is receiving funding this year for monitoring so, we need to accelerate our inventories to collect data that will allow refinement of identified sampling protocols and allow calculation of sample sizes. Funding levels in the Inventory Initiative will only support distribution surveys based on presence/absence over very broad strata. Due to logistical constraints, a monitoring program will of necessity, be based on a few sites that will be sustainable in the long run. Having a good inventory/distribution database will allow inferences for a larger land base, and facilitate directed

studies if monitoring indicates that there are areas of concern. Therefore, development of monitoring protocols requires extensive sampling with more replicates for selection of sample sizes. We have chosen to focus abundance and distribution studies on species that have already been identified as potential species for long-term monitoring programs through scoping sessions at the prototype parks and concurrence by resource specialists in the other network parks. In most cases, these species reflect management concerns or stressors to park ecosystems, or species that have been successfully monitored in past programs. Since there is not adequate funding, in the Species Inventory Initiative, to conduct surveys of the intensity needed for refinement of sampling protocols we are proposing to supplement this funding with Network Monitoring funding to accelerate these complementary programs.

Table 4. Priorities for Inventory Work Elements.

Task	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH
Document at 90% Verification Level				**Priority 1**			
Method - Searches of Literature & Collections	1	1	1	1	1	1	1
Birds	1	1			1	1	1
Mammals	1	1			1	1	1
Amphibians & Reptiles	1	1				1	
Fish	1	1		1		1	1
Vascular Plants	1	1		1	1	1	
Method – Field Surveys							
Birds	1	1	1		1	1	1
Mammals		1	1		1	1	1
Amphibians & Reptiles			1				1
Fish		1		1			1
Vascular Plants	1		1		1	1	1
Collect Existing Spatial Data				**Priority 2**			
Assemble existing data , enter into NPSpecies and link data with park GIS	2	2	2	2	2	2	2
Distribution and Relative Abundance Surveys				**Priority 3**			
Birds & Mammals	3	3		3	3	3	3
Amphibians & Reptiles		3		3	3		3
Fish				3	3	3	
Plant Species of Special Concern				3	3	3	
Exotic Plant Abundance and Distribution		3		3	3	3	
Total							

Overview of Program Priorities

Data Mining

We will continue the data mining in order to populate NPSpecies. We hope to wrap up the search for vouchers from collections when the searches of the national collections are complete. The next phase will include the addition of species documented by published records in scientific studies. The results of the data mining activities may affect the final design or priority of field surveys tentatively planned for years 2-4.

In year 2, the focus for NPSpecies work at the NCC Network will be the assembly of existing spatial data into NPSpecies (Table 4). Biological technicians stationed at FOCL, MORA, NOCA, and OLYM will conduct all data mining. The FOCL biological technician will be responsible for data from FOVA and FOCL. The biotech at NOCA will input data for EBLA, SAJH, and NOCA into NPSpecies. The Network will hire three Data Managers with Long Term Ecological Monitoring Funds (LTEM). The Data Mangers will be stationed at MORA, NOCA and OLYM and will assist with data input in FY01 in order to gain familiarity with the NPSpecies databases and assure their integration with taxa specific databases and collections databases. In year FY02, they will assist with conversion of spatial data into the appropriate format. Katherine Beirne (GS09) of OLYM will also assist with data storage oversight for spatial data. The CCSO (Craig Dalby) will provide assistance with identification and storage of spatial data for FOCL, FOVA, EBLA, and SAJH. The Budget for Data Mining and Spatial Data assemblage is summarized below. It is important to note that biological technicians working on field surveys will input data they collect and funding for that task is included in the field survey budgets.

Cost Category	**EBLA**[1]	**FOCL**	**FOVA**	**MORA**	**NOCA**	**OLYM**	**SAJH**	**CCSO**	**LTEM Match**
FYO1									
Data Manager, GS-011, 13 pp									$30,000
Bio-tech, GS06 @$1040/pp	$2,180	$2,180	$2,180	$6,540	$6,540	$7,280	$1,090		
Total FY01 funds	Species Inventory Funds - $28,340								$30,000
FY02									
Data Manager, GS-011, 13 pp									$30,000
GS09, Beirne						$ 5,870			
Bio-tech, GS06 @$1040/pp	$2,180	$2,180	$2,180	$14,170	$14,170	$10,400	$5,450	$5,000	
Spatial data – MORA[2]									$10,000
Total FY02 funds	Species Inventory Funds - $61,600								$40,000

[1]EBLA and SAJH funding will support the biological technician stationed at NOCA. The FOVA funding will support the biological technician at FOCL.

[2]This funding was received in 2000 (GIS funding) and used to input 7,000 geo-referenced records on voucher specimens. It is mentioned here because most geo-referenced data will be input in 2001, but the experience gained with these records will assist in our planning for transfer methods in 2002.

90% Verification

Development of verified species lists is the first objective of the North Coast and Cascades Network Study Plan. Data mining of voucher collections, scientific literature, and observational data will be completed in 2001. In some cases, it is already apparent that there is insufficient data to reach 90% verification through data mining alone. In these specific cases (i.e. taxa groups), field studies are planned to reach 90% verification. Field surveys have been designed to meet each individual taxa group or parks needs. Survey designs vary with site and include unconstrained searches of entire parks, complete searches of specific habitats, and probability-based sampling strategies.

EBLA will provide a unique opportunity for multi-agency collaboration. Of the 17,400 acres included within the Reserve, the NPS only owns 35 acres. The remaining acreage includes 5,500 landowners encompassing state agencies, private non-profit organizations (e.g. The Nature Conservancy), the military, and private individuals (see Figure 2). Species inventories will focus on large, unmodified areas that potentially encompass functioning ecosystems. Most of these areas are state or county parks or areas owned by non-profit organizations. During 2001, we will contact all agencies to collect data and determine where data gaps require field surveys to reach 90% verification. We plan to invite our collaborators to organize "bio-blitzes" to collect the remaining data. We feel these efforts will provide a means to inform the public about the National Park Species Inventory at all parks and in particular EBLA. The Reserve is currently writing its GMP and the data from the Species Inventory will assist in development of this plan.

Distribution Surveys

Distribution surveys are planned to gather in-depth information on taxonomic groups within the network. The groups have been selected based on their potential as indicators in LTEM programs, management concerns, and availability of established protocols. Most sampling designs are stratified based on accessibility criteria to meet multiple objectives of obtaining adequate sampling sizes and increasing our areas of inference. Project specific sampling designs are included in each project statements.

Individual Study Plans

Project Title: Landbird Inventory

Program Leads: Bob Kuntz, NOCA; Dr. Patti Happe, OLYM; Jim Petterson, MORA

Problem Statement

The NCC Network Terrestrial Vertebrate Workgroup identified, as their highest priority, a need to survey landbirds to determine presence and gather data on their distribution and habitat use. Vital signs workshops at OLYM and NOCA, as part of developing long-term ecological monitoring programs, identified landbirds as a high priority taxonomic group. Birds are an important component of park ecosystems. Their high body temperature, rapid metabolism, and high ecological position in most food webs make birds good indicators of the effects of local and regional changes in ecosystems. Birds represent the most species rich vertebrate taxonomic group in the NCC Network parks. Lastly, birds have a tremendous following among the public, and many parks provide information on the status and trends of birds in their parks through their interpretive programs.

Reported declines of many resident-migrant birds have stimulated interest in avian population trends across North America. Suggested mechanisms driving these declines include habitat loss (Rappole and McDonald 1994; Sharp 1996; Wilcove et al. 1998), habitat fragmentation (DeSante and George 1994), habitat succession (Sharp 1996), increased nest predation (Morse and Robinson 1999) and nest parasitism, and increased mortality during migration. Regional trends in the Northwest indicate declines in species associated with late successional forests and riparian areas (Sharp 1996). Because impacts of these mechanisms are confounded by population fluctuations due to climatic variation (DeSante et al. 1996, 1998), data on avian populations are needed from large parks and protected areas where changes in land use have been less severe. Unfortunately, such data are lacking for most large protected areas due to difficulty of access and limitations on research personnel.

This project has several research and management implications relevant to all 7 National Park Service units in the North Coast and Cascades Network and lands beyond their boundaries. First, quantifying avian habitat relationships will facilitate predicting consequences of management decisions within and outside the park, including decisions about fire management, visitor use, snag removal, and forest harvest in non-NPS lands. Second, data on avian distributions and population densities will provide a baseline for future comparisons within and beyond park boundaries. Third, patterns and trends of concern identified for particular bird species will alert researchers to look for trends in species that are less conspicuous than birds but that use similar resources. In this way, collecting data on many bird species can provide a screen for problems in other taxa that otherwise would pass undetected.

Historical Inventory Work

Mount Rainier National Park

Field inventories were conducted in 1897, 1919, and 1934-36, with approximately 1,200 voucher specimens collected. Wildlife observational records have been recorded since 1936, but observer

reliability is variable and/or unknown. Multi-species, community-level avian fieldwork has been done in the last 20 years, but only a portion of these data are in the park files; some of this information can be found in refereed literature and theses/dissertations. One book relating to Mt. Rainier's birds has been published in 1927, and various annotated checklists during the following years. A revised, outdated park checklist exists from 1995 that lists 159 species of birds occurring within the park.

North Cascades National Park Complex
A checklist has been compiled from documented records showing relative abundance for 200+ species within the Park Complex. Relative abundance and distributional data have been collected during 11 years for winter landbird populations as part of the Audubon Christmas Bird Count and for 10 to 28 years on 3 standard roadside U.S. Fish and Wildlife Service breeding bird survey routes. Incidental sighting records have been documented in a wildlife observation database.

Olympic National Park
There are an estimated 301 bird species that occur on the Olympic Peninsula; how many of these inhabit the park, and relative abundance and distribution data for the park for most species are unknown. A list of avian species present in the park was developed from informal qualitative breeding season surveys. Area search studies were conducted during the mid 1980's on 5 plots in the western part of the park and 2 standard roadside U.S. Fish and Wildlife Service breeding bird survey routes have been done for 15 years. Landbird point counts have been conducted from approximately 100 stations during 1998-2000 as part of protocol testing for LTEM.

Ebey's Landing National Historical Reserve
No bird inventories have been conducted, but a literature survey completed in 1980 listed 130 bird species from the region.

Fort Clatsop National Memorial
A bird list was compiled from existing park records that includes 109 species. Abundance data is summarized for 100 species based on observations from October 1992 to December 1993.

Fort Vancouver National Historic Site
A "Wildlife Resources Report" was completed in 1993 that contains a variety of background material and recommendations on optimizing wildlife habitat for native species. It also contains an actual and hypothetical listing of species, including; mammals, birds, reptiles and amphibians, and fishes. It is the only known biological survey of the park site.

San Juan National Historical Park
No park-specific bird inventories have been conducted. Several checklists assembled in 1965, 1987, and 1996 list 200 species of birds in the San Juan Islands Archipelago.

Objectives

The first objective of the landbird inventory is to document species presence in all network parks. Currently, four Network parks (EBLA, FOCL, FOVA, and SAJH) lack checklists, or have incomplete lists based on limited or undocumented data. At these small parks, our work tasks have been designed to document, to the 90% verification level, bird species found in these parks.

The second objective of the landbird inventory is to collect data on distribution and habitat use to develop long-term monitoring methods. Each of the Network's three large parks (MORA, NOCA, and OLYM) has fairly complete checklists (Table 2). However, these parks lack information related to species-specific distributions and habitat use. At the large parks, our objectives will include:

- Determine species-specific distribution patterns of breeding landbirds across broad geographic, elevation, precipitation, and habitat gradients.
- Determine species -specific bird-habitat relationships.
- Continue to document, to the 90% verification level, species expected but undocumented.

Methods

Objective 1: 90% Verified Species Lists
Location: EBLA, FOCL, FOVA, and SAJH

A form of the area search method will be used to document species presence in these parks due to their relatively small sizes (130 – 1,700 acres). Areas searches most effectively survey relatively limited, well-delineated areas and allow relatively small parcels of land to be thoroughly traversed (repeatedly) during the search. The area search method simply requires that observers roam freely for a fixed period of time in a specified area, tallying numbers of each species detected (Lyon, 1986; Slater, 1994). This method is particularly well suited to surveys relying on observers with diverse skill levels (Siegel, 2000).

To insure this effort will produce credible information, the following steps will be taken:

1. The skill level of each observer will be evaluated and documented.
2. Observers will map the routes walked on maps and will record survey data on forms, that include species encountered, location (either mapped or given a management zone or habitat designation), dates, and other relevant information. This data will be stored in computer files.
3. Observations of uncommon to rare species will be further documented by written descriptions of plumage, songs and calls, and pertinent behaviors. If possible, photographs will be taken.

To insure adequate and extensive coverage, a grid or management zone framework will be developed at each park. Sampling will occur in cell or zone. Sampling will occur once each

month for 1 year (3 times in each season). Visits each month will be separated by at least 2 weeks.

Objective 2: distribution surveys
Location: MORA, NOCA, and OLYM

Surveys will document species-specific breeding bird distributions and habitat associations by establishing a series of patches (or transects) where we will conduct approximately 8-12 variable circular plot (VCP) point-counts with distance estimation. This form of distance sampling has been used for more than 30 years to estimate animal abundance and is generally considered the best method currently available for determining relative abundance or trends for most bird species (Sauer and Droege, 1990; Ralph et al., 1995; Fancy,2000). Basically, VCP point-counts consist of an observer standing at a specified point and recording all birds detected by either sight or sound during a 5-minute period. The distance to each bird is estimated to allow calculation of detection probabilities of birds at increasing distances from the observer (Buckland et al. 1993).

In addition to recording all birds seen or heard at each point-count station, we will document the location of each point (using GPS), identify the habitat class using each park's current GIS habitat classification system (e.g. for NOCA: Pacific Meridian Resources 1996), and record information on slope, aspect, and weather. We will also describe site vegetation structure and composition using a modified relevé procedure. During the first visit to each point count station, we will conduct rapid habitat assessments of the area within a 50 meter radius circle of each survey point. Habitat assessments will be conducted by a second observer (not the person conducting the bird point counts), who will lag behind the bird observer by at least one full survey point to avoid affecting point count results. Habitat assessments will entail assigning a primary (and, if appropriate, a secondary) habitat classification to each point, utilizing NOCA's existing vegetation classification system. We will also collect more detailed data on vegetation structure and composition within a relevé, a variable-radius circular plot centered on the survey point. We will record total cover, average height, and species composition of four vegetation layers (ground-cover, shrub, sub-canopy, and canopy) at 10, 20, 30, 40, and 50 meters in each cardinal direction from the central point. We will also rapidly assess a variety of other habitat characteristics that are likely to affect the local landbird community, including the abundance of snags, downed wood, and running or standing water, and the size class of dominant tree species. Finally, we will also record slope and aspect of each survey point. These data will enable us to couple vegetation and ecological correlates of avian species richness, avian abundance, and densities of individual bird species.

Sampling Design

We will establish a spatially extensive series of multi-point transects across each park. Sites will be selected using a stratified random sampling method based on the follow criteria: (Criteria may vary slightly based on individual park's situations and needs)

1. Accessibility - 20% of the sites will be at front-country sites (sites within 1.5 km of roads or trailheads); 60% at accessible backcountry sites (sites within 1.5 km of maintained trails, less

than 20 km hike); and 20% at remote backcountry sites (remote sites over 2 km from maintained trails; may require greater than a 20 km hike to access).
2. Forest / Vegetation zones - Western hemlock (*Tsuga heterophylla*), Pacific Silver Fir (*Abies amabilis*), and Mountain Hemlock (*Tsuga mertensiana*) which will also include the subalpine parkland and alpine zones.
3. Special areas of concern - sites that include areas where significant NPS management occurs (e.g. along the Skagit River, lower Stehekin Valley) and rare or significant habitats unlikely to be selected by our random site selection process.

Park areas with slopes greater than 35 degrees will be eliminated from our sampling universe due to safety concerns. In Year 1, we plan to sample 45 of the 65 sites selected. In Year 2, we will sample the 20 sites not sampled in Year 1, plus resample approximately a third of the sites (25) sampled the previous year.

Decisions on the design of the NCC network long-term vital signs monitoring program have yet to be worked out. We anticipate completion of the network plan by the end of 2002. If it is determined in the future that the network vital signs monitoring program will not include bird monitoring at MORA, the inventory effort conducted in MORA will focus to a greater extent on documenting species presence and to a lesser degree on determining species-specific distribution patterns and bird-habitat relationships. This could be accomplished by reducing the relative effort at VCP surveys in MORA during one or both years. The VCP surveys could then be augmented with a combination of other methods better suited to detecting other species in a manner similar to what is being proposed in the smaller parks such as using area searches in biologically rich or rare habitats or performing nocturnal surveys. Work would be conducted primarily between March and November. If MORA is included in the network long-term bird monitoring program, then fieldwork will be followed as described for NOCA and OLYM. Since fieldwork is not scheduled to begin at MORA until 2003, the need to remain flexible should not impact the initiation of fieldwork at the other parks.

Schedule

Field data collection is scheduled to be completed in the first 4 years of this program. This will allow an extra year if anomalous weather (i.e. heavy snowfall during the previous winter) and will give us time to analyze data and prepare technical reports. The following table outlines when each park will be sampled.

	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH
2001					x		
2002	x				x	x	x
2003		x		x		x	
2004			x	x			
2005							

Coordination and Logistics

We plan to contract out all surveys. Park wildlife biologists will administer agreements of the contracts for each park. MORA's wildlife biologist will oversee the verification studies at FOCL and FOVA. NOCA's wildlife biologist will oversee the verification studies at EBLA and SAJH, as well as the VCP study at SAJH.

Budget

Budget Overview

Objective	**Location**	**Number of Years**	**Annual Cost/Park**		**Total Program Cost**	
			Inventory Funds	**LTEM**[1]	**Inventory Funds**	**LTEM Funds**
1. Species List	EBLA, FOVA, FOCL, SAJH	1	$ 6,700		$26,800	
2. Distribution & Habitat	MORA, NOCA, OLYM	2	$16,666	$31,333	$100,000	$188,000
2. Distribution & Habitat	SAJH	1				
Total Inventory Request					$126,800	

[1]LTEM funds refer to Long-term Monitoring funds for the North Coast and Cascades Network

Budget Itemization

Cost Category	**Species Inventory Funds (Annual Costs)**		**Cost Share – LTEM Funds**
	Objective 1: Species List	Objective 2: Distribution MORA, NOCA, OLYM	Objective 2: Distribution MORA, NOCA, OLYM
Personnel:			
Supervisor (Park Bio., 1 FTE)			
Research Scientist ($4,050/month)	$2,025	$3,800	$5,300
Staff Biologist ($2,894/month)		$601	$840
Field Biologist ($2,205/month)		$3,218	$4,500
Benefits (30% of salaries)	$622	$2,304	$3,180
Intern Stipends ($32/day)	$ 1,504	$2,720	$4,000
Travel	$340	$650	$1,000
Housing	$300	$900	$1,200
Data Entry	$150	$420	$580
Equipment/Supplies	$100	$420	$580
Indirect Costs: (33%)	$1,659	$4,967	$6,820
Total (annual per park)	$6,700	$20,00	$28,000

Products

- Annual reports for each park.
- Final Technical Report for each park completing the VCP surveys.
- Checklists of verified species that include data on seasonality and distribution (either management or habitat zones used).
- Verification documents for all species at each park where those species are currently undocumented.
- Recommendations for a proposed sampling scheme to be used at Pacific Northwest parks for long-term ecological monitoring of landbirds.

Project Title: Forest Carnivore and General Mammal Inventory
Program Leads: Jim Petterson, MORA; Dr. Patti Happe, OLYM; Bob Kuntz, NOCA

Problem Statement

The second highest inventory priority for terrestrial vertebrates in the NCC Network is a survey of forest carnivores. This taxonomic group was ranked a high priority for several reasons. Firstly, all the parks in the network have very little information on forest carnivores. This lack of data stems primarily from the fact that forest carnivores have historically been very difficult to study, especially in remote, wilderness areas. However, several recently developed techniques and protocols for surveying forest carnivores offer alternatives that are cost effective, non-intrusive, and amenable to a wilderness environment (Aubry 1997, Zielinski and Kucera 1995). In addition, these methods can be used for more than one species at a time. These survey protocols have wide acceptance region wide, and have been employed by multiple land management agencies. However, the NPS has yet to systematically employ them in our network.

Additionally, several forest carnivore species are listed on either federal or state endangered species lists (Federal: lynx, wolf, grizzly bear. State: fisher), have recently been petitioned for listing (wolverine), are soon to be proposed for listing (Federal: fisher, coastal marten), or are of special management concern (cougar). Many species of forest carnivores experience numerous threats that have caused for concern about their status (habitat loss, isolation of any remnant populations in protected areas such as national parks, long standing effects of historic harvest pressure, and loss of major food sources – i.e. salmon) (Ruggiero et al. 1994). Most recently, wildlife biologists from state and federal agencies in Oregon and Washington met and formed and *ad hoc* Pacific Northwest Forest Carnivore Group. The groups' goal is to work together across jurisdictional boundaries to gather more information on these key taxa. Better quality data on forest carnivore presence and distribution within the parks in the region is key piece in that effort.

The four smaller parks (FOCL, FOVA, EBLA, and SAJH lack complete mammal species lists and adequate verification for those species expected to occur there. This, combined with the fact that few forest carnivores are expected to exist in these smaller units, argues for concentrating effort at documenting mammals to the 90% verification level at these locales.

Objectives

Our primary objective is to gain information on species presence (i.e. complete the 90% accurate species list with current data). For most of the larger parks, some forest carnivore species have not been documented for over 40 years, and several are suspected to be extirpated (fisher in MORA, NOCA, and OLYM, wolverine in NOCA, MORA, wolf in OLYM, MORA, and Canada lynx in MORA). The only objective at the smaller parks is to generate an updated presence/absence list of mammal species occurring that reflects the service-wide target of 90% completeness.

The secondary objective at larger parks is to gain insight on species distribution patterns across broad geographic, elevational and precipitation gradients. However, sample sizes are expected to be too low for statistical analysis.

Methods

Sampling Methods at the large parks (MORA, NOCA, OLYM)
The survey will attempt to "capture", either by photograph or hair snare, small to medium sized carnivores, with emphasis being place on those that inhabit old-growth forests and riparian areas. Expected species include: Mustellids: wolverine, fisher, marten, mink, river otter, long-tailed weasel, ermine, spotted skunk, stripped skunk; Procyonids: Raccoons; Felids: cougar, bobcat, lynx; Canids: wolf, coyote, red fox.

The survey will take place from Feb 1- May 1 (3 mos.). Based on results from other studies, this is the best time to do this kind of a survey: 1) Bears are in hibernation, and consequently will not destroy the traps. In addition, we will have less concern about creating hazard/nuisance situation. 2) In MORA, NOCA, and OLYM deep snows in higher elevations will concentrate several species into lower elevation areas, increasing chance of capture when compared with the summer months. 3) We will be able to take advantage of good snow tracking events, and be able to augment "trap" sampling with track surveys. 4) Late winter/early spring is the breeding season for some of the target species (fisher, wolverine). With increased travel during this time, particularly males in search of mates, trap success may be increased.

Sampling will follow the basic design laid out in Zielinski and Kucera (1995), with field implementation following recommendations of Aubry (1997, pers. comm. 2000). However, we will make modifications to the technique to accommodate the park setting. Using GIS, the target parks will be partitioned into 4 mi^2 sampling units, consisting of 4-1mi^2 blocks. Sample blocks will be aligned on the trail and road network (versus using the TRS network used by the forest service, which does not exist in most parks).

Due to the difficulty of working during the winter (short days, inclement weather, avalanches), the fact that most sites will be accessed by foot, and the amount of material that must be packed to each sample site, the sample universe will be confined to all accessible areas within 1.5 km from roads and trails. Backcountry sites will be sampled up to 20 km from trailheads at elevations up to 2000' (approximate snowline), up to 10 km from the trailhead at elevations between 2000 and 4000', and up to 3 km from the road at elevations > 4000'. We will systematically select blocks to sample.

In each selected block, 2-1mi^2 sub-sampling units will be randomly chosen. Within selected sub-sampling units, trap stations will be installed at suitable sites. Suitable sites will be 1) randomly chosen points between 0.1 and 1.5 km away from a road or trail, 2) in either old-growth or riparian forest, and 3) safely accessible (i.e. no mid-winter river crossings or traversing avalanche chutes). Within each sample unit, trap stations will be at least 1.6km apart. Because our sampling will be restricted to areas near roads and trails, our area of inference will be limited to those areas. However, given the nature and the timing of the survey, we do not feel that it is

either safe, or practical, to extend this type of sampling to more inaccessible areas. What we lose in area of inference we gain in both increased sample size, and in crew safety.

Key habitat variables will be recorded at each site, including vegetation type, elevation, aspect. All site locations will be recorded with a differential GPS.

At each site, the "trap" station will consist of:

- A dual sensor camera, focused on bait consisting of:
  - Whole feathered chicken tied to a tree
  - Fish at base of tree
- Marten cubby, with sticky hair pads and baited with scent lure and chicken wing
- Pie plate (visual attractant)
- Call scent (olfactory attractant)
- Hair-snag pad, nailed to a tree, baited with lynx lure.

Stations will be left out for at least 28 days, will be checked every 7-10 days, and at the end of the sample period, they will be relocated to another site. We will have 20 cameras per large park per year. Site sample schedule will be clustered for sampling efficiency, yet will sample systematically to ensure coverage on all gradients of interest between years and season (i.e. balance east Vs west, high Vs low in year 1 and 2, early and late winter)

With 2 cameras per selected sample unit, and a 3 month sample period, the most we can hope to accomplish is to sample 30 sites per year, or 60 sites over the scheduled 2 year inventory effort in each of the large parks. However, given logistical constraints, the predicted sample size per large park is 50 sites.

Sampling Methods at small parks (EBLA, FOCL, FOVA, SAJH)
Efforts will concentrate on compiling known data sources and obtaining experts' opinions to produce an expected species list that will be used to gauge when the 90% level of verification has been reached. For those species where insufficient information exists to document presence, standard field inventory techniques will be used to make determinations. Because the parks in question are small in area (<1,700 ac.), complete sample coverage is expected. A variety of sample techniques will be used to address the species-specific differences associated with effectively capturing or documenting presence. Live-traps and pitfall traps will be used to capture rodents, shrews, and small carnivores; mist nets and acoustic recorders will be used to document bats; and infra-red triggered cameras will be used to record larger carnivores and ungulates. Samples will be distributed among the various habitats occurring across the landscape, with Sherman trapping grids interspersed with camera sets and larger box traps.

Timing of Field Surveys

Our goal is to complete the scheduled inventory in 4 years. This will give us a cushion of one extra year in case there is anomalous weather (i.e. another deep snowfall year that precludes safe access to most of a park) and time to analyze data and prepare reports. The schedule is set up so that we stagger the start year in each of the targeted parks, with only one park (MORA) starting

out in year 1. This will allow for bugs to be worked out in one park, and the lessons learned and passed along to the rest of the network on subsequent years. Because of the discrepancy in park size, and consequent availability of suitable habitat, absolute sample effort will not be equal between all parks.

Forest carnivore sampling will occur from February through April in each of the three large parks (MORA, NOCA, and OLYM). Sampling at each of the four smaller parks will occur during a two-week period in May, following the forest carnivore sampling at the big parks. Each small park will receive sample effort for only one year, with Mount Rainier N.P. being responsible for covering FOCL and FOVA in 2001 and 2002, respectively and North Cascades focusing on SAJU and EBLA during 2003 and 2004, respectively.

	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH
2001		x		x			
2002			x	x		x	x
2003					x	x	x
2004	x				x		
2005							

Coordination and Logistics

The field crew will consist of a GS06 biotech and volunteer (s). Data entry will happen throughout the inventory (on the last day of the tour).

The park wildlife biologist will: 1) closely supervised the field crew, 2) inform and involve other park staff in the project (because this will be taking place in the "off season", it is an ideal opportunity to involve interested staff from other park divisions), 3) coordinate efforts with other park wildlife biologists within the network, 4) communicate with and coordinate with interested adjacent land managers and the Pacific Northwest Forest Carnivore working group, and 5) summarize the data and prepare the annual and final reports.

Field efforts will be able to use field gear already purchased by other projects, which run during the summer months. This includes camping gear, GPS, etc. Vehicles are to be supplied by the park (take advantage of rigs not used in the off season).

Budget

Budget Overview

YEAR	Distribution of Funds			Total Annual Funding	Location of Field Work and Responsibilities
	MORA	NOCA	OLYM		
2001	16,000			$16,000	Pilot year, will do MORA and FOCL. Will purchase additional cameras
2002	12,500		12,500	$25,000	MORA biologist will also survey FOVA
2003		12,500	12,500	$25,000	NOCA biologist will also survey SAJH
2004		12,500		$12,500	NOCA biologist will also survey EBLA
Total Species Inventory Request				$78,500	

Budget Itemization

Cost Category	Species Inventory Funds		Park Matching Funds (ONPS)	
	Annual Cost	One time Cost	Annual	One time
Personnel/travel				
Supervisor (Park Bio, .1 FTE) avg 12/01			6,890	
Biotech –(gs06) pp3-9 (7 @1073/pp)	7,525			
Volunteer support/housing	1,000			
Field per diem (7pp*4days out/pp*$15/day)	425			
Travel (to FOCL/EBLA etc)	500			
One-time equipment:				
field gear (camping stuff*)(most from other projects)*	250			600
2 Bat detector (anabats)				2,500
Field computer				2,000
Small mammal traps				3,000
Cameras 7* 500 ea. (need 50, have 43 in stock)		3500		12,500[1]
Ongoing equipment/supplies				
Film, development, batteries, lures, hardware, hair pads	2000			
DNA analysis (assume 40 samples/year*$20/sample)	800			
Vehicles 1@ $400/mo*3 mos			1,200	
Annual Total (per large/small park combination)	12,500	3,500	8,090	20,600
Project Total (over 4 years of the project)	75,000	3,500	48,540	20,600

[1] OLYM has 25 cameras in stock that will be used by the network in this effort. 18 additional units were purchased with inventory funds in FY2000.

Products

- Updated presence/absence list of mammal species occurring that reflects the servicewide target of 90% completeness.
- Annual reports.
- Data shared with interagency Pacific Northwest Forest Carnivore Group, state heritage database
- The methods we propose to use have been used by several agencies on federal, state, and private lands throughout the Northwest. Consequently, others will also be able to compare their results from managed landscape to ours.
- For key species, results will identify areas for future research. For example, fisher are currently being proposed for reintroduction. If we do not find any, this data will add further weight to that proposal, for the state and USFWS have search all other suitable habitat in the Washington. Information on wolverine and lynx will aid NOCA and MORA in their ESA compliance, and aid the overall recovery efforts. Coastal marten are being considered for listing; our results in OLYM are expected to influence that decision.

Project Title: Amphibian Inventory

Program Leads: Barbara Samora, MORA; Reed Glesne, NOCA

Problem Statement

The status of amphibian populations has long been a concern in the Pacific Northwest. Habitat requirements of amphibians in late-successional forests of the Pacific Northwest have received some attention by the U.S. Forest Service over the past 15 years but further work is needed to better understand how habitat variation affects population viability. Because amphibian species are associated with riparian systems, understanding the relationships between riparian management and amphibian population dynamics is a high priority. In addition, further work is needed to better understand the population dynamics of rare and locally endemic species such as Van Dyke's and Larch Mountain Salamanders (USDA Forest Service and DOI Bureau of Land Management 1994). The Northwest Forest Plan identifies several amphibian species as high priority "survey and manage" species; many of these occur within the North Coast and Cascades National Park Network (NCCN) parks.

In 1994, MORA, NOCA and OLYM identified the lack of information on amphibian species distributions and abundances as the highest priority issue to address cooperatively with the newly created U.S. Geological Survey Biological Resources Division (BRD). NPS and BRD began inventories of aquatic breeding amphibians in these parks in 1996. The inventories continued through 1999 and several reports have been or are being prepared (i.e., Bury and Adams, in prep; Samora et al., in prep A; Holmes and Glesne 1998, 1999). Recent Vital Signs workshops at OLYM and NOCA identified amphibians as a high priority taxonomic group for long-term ecological monitoring.

Amphibians are important members of terrestrial and aquatic ecosystems because they occupy key trophic positions in food webs. As adults they can be top carnivores, and as eggs, larvae or juveniles, they may be the major food source of many other species including birds, mammals, fish and invertebrates. In some forest ecosystems, amphibians may comprise the major component of the vertebrate biomass (Burton and Likens 1975, Bury 1988). Moreover, amphibians are good "bioindicators" of environmental stress because of their complex life histories. Amphibian declines may be an early warning signal that other organisms also may be in danger of decline or extinction (Blaustein and Wake 1990; Bury et al. 1980; Phillips 1990; Wake 1991; Wyman 1990).

Assessments of the status of amphibian populations in the Pacific Northwest have been difficult to complete because: 1) the number of long-term inventory and monitoring efforts has been limited; and 2) few if any comparable data sets are available (Olson and Leonard 1997). Yet, human-related activities have disturbed many amphibian habitats (Fellers and Drost 1993; Blaustein and Wake 1995; Bury 1999). For example, fish stocking, logging practices, and alteration of streams, wetlands, and riparian areas, have had widespread impacts on amphibian communities.

Several amphibian species expected to be present in our network parks are listed as species of concern on federal and state endangered and threatened species lists. These include *Rana*

cascadae, Rana pretiosa, Rana luteiventris, Rana aurora, Plethodon vandykei, Plethodon larselli, Rhyacotriton olympicus, Bufo boreas, and *Ascaphus truei.* Amphibians that would likely occur in the NCCN parks are listed in Table 5

Eleven species of reptiles occur, or would likely occur within parks in the NCCN (Table 5). Most reptile species are common and none of these are special status species. MORA and NOCA are at the 90% verification level for reptiles. FOCL is at the 66% verification level, only missing verification for one species. FOVA, SAJH and EBLA have no verified list of reptiles, however additional searches of museum specimens and state records have not been completed.

Table 5. Amphibian and Reptile species expected to be present in network parks, and their status.

Terrestrial or Riparian species	**Special Status Species**	**Exotic Species**	**MORA**	**NOCA**	**FOCL**	**FOVA**	**SAJH**	**EBLA**	**OLYM**
Ensatina eshscholtzi			C	C	+	+	+	+	C
Plethodon vehiculum			C	C	+	+	+	+	C
Plethodon vandykei	*		C		+				C
Plethodon larselli	*		C						
Plethodon dunni					+				
Aneides ferreus					+				
Aquatic Species									
Ascaphus truei	*		C	C					C
Dicamptodon tenebrosus			C	C				+	
Dicamptodon copei			+		+				C
Rana aurora	*		C	C	C	+	C	+	C
Rana cascadae	*		C	C					C
Rana catesbeiana		#			+		+	+	C
Rana pretiosa	*				+[1]		+	+	
Rana luteiventris	*			C					
Hyla or Pseudacris regilla			C	C	C		C	+	C
Bufo boreas	*		C	C	+	+	+	+	C
Ambystoma gracile			C	C	C		+	+	C
Ambystoma macrodactylum			C	C	C		+	+	C
Taricha granulosa			C	C	+		+	+	C
Rhyacotriton kezeri					+				
Rhyacotriton olympicus	*							+	C
Rhyacotriton cascadae			+						
Total Species	9	1	15	12	15	4	10	12	14

+ = expected, C = confirmed present * = federal or state listed species of concern # = introduced species

[1] R. pretiosa was reported in 1805 but no recent surveys have been conducted for this species.

	Reptile Species	Special Status Species	MORA	NOCA	FOCL	FOVA	SAJH	EBLA	OLYM
1	Elgaria coerulea		c	c	+	+	+	+	+
2	Sceloporus occidentalis			c					+
3	Charina bottae		c	c					+
4	Coluber constrictor			c					
5	Thamnophis elegans		c	c			+	+	+
6	Thamnophis ordinoides		c	+	c	+	+	+	+
7	Thamnophis sirtalis		c	c	c	+	+	+	+
8	Crotalus viridis			c					
9	Chrysemys picta		c	c					
10	Pituophis catenifer			+					
11	Eumeces skiltonianus			+					

+ = expected, c = confirmed present

Objectives

The primary objective of this inventory is to document species presence. Currently, four NCCN parks (EBLA, FOCL, FOVA, and SAJH) have incomplete lists based on limited or undocumented data. At these small parks, our primary goal will be to document, to the 90% verification level, amphibian species found in these parks.

NOCA and OLYM have complete checklists of amphibian species. MORA is at the 86% verification level, lacking documentation for only two species. All three of the large parks have sufficient information on species-specific distribution patterns across elevational and precipitation gradients with two exceptions. MORA lacks information on two special status terrestrial, and two undocumented and one special status aquatic species. NOCA lacks information on distribution and abundance of amphibians in lotic systems in four watersheds, including one special status species.

MORA has reached the 90% verification level for reptile species. OLYM is presently inventorying reptiles with their ongoing terrestrial herptofauna inventories. NOCA has reached the 82% verification level, missing confirmation of three species. Inventories of reptiles will be conducted in FOVA, FOCL, SAJH, and EBLA, using the same protocols described for terrestrial amphibians. Inventories of reptiles in NOCA will be conducted on an opportunistic basis by park staff conducting other studies, including the stream amphibian survey.

Additional searches of museum collections for voucher information will be completed as part of these inventories.

Survey Design

Several survey techniques and sampling strategies will be used to accomplish this task because no single technique will adequately document the presence of all amphibian species.

The main emphasis of inventories in small parks will be to document species occurrence within all potential habitats. National Wetland Inventory maps or hydrography will be used to identify these habitats. Techniques appropriate for surveying both terrestrial and aquatic amphibian species will be used so that 100% coverage of suitable habitat will be attained at these parks.

The main emphasis of inventories in MORA and NOCA are to target specific habitats or geographic areas within the park that are likely to yield data on undocumented species and species of special concern. Target habitats in MORA and NOCA will be stratified based on physical and ecological attributes based upon the species and habitats of interest.

Methods

A variety of techniques will be used to sample for amphibians since one technique will not adequately sample all species.

Terrestrial Amphibians and Reptiles

Terrestrial herptofauna will be inventoried according to Bury and Adams (2000). Each quadrant of each plot will be searched for 30 worker minutes during daylight (more than one hour after sunrise and before sunset). A search consists of workers methodically searching visually for amphibians over the entire area of the plot and looking under as much loose wood, bark, or rock that can be lifted and restored to a condition similar to its original state. Field habitat measurements will be documented and include primary forest association series; canopy cover; slope; aspect; presence of streams, seeps, or talus; relative cover of each overstory species and size class categories for stems from each tree species; dominant understory cover and percent grasses, mosses and coarse woody debris, and the decay class for coarse woody debris.

Aquatic Amphibians

Lentic habitats include ponds, lakes, tarns, springs, potholes, large meadows, and wetland complexes. Lentic habitats will be surveyed with a combination of visual searches; snorkel surveys and funnel trapping. Visual surveys and funnel trapping will be conducted according to protocols described by Bury and Major (1997). Snorkel surveys will be conducted for sites more than one meter deep according to protocols described by Liss et al (1995) and Tyler et al. (1998). Field habitat will be documented through mapping and measurements including surrounding forest and understory cover; National Wetlands Inventory type; environmental zones (littoral, riparian, inlet/outlet stream channels, limnetic) and macrohabitat; air and water temperatures; water depth; aquatic vegetation; and substrate including coarse woody debris.

Lotic habitats include large rivers and their tributaries, rivulets, and seeps. Lotic habitats will be surveyed according to Bury and Adams (in prep). Field habitat measurements will be

documented including National Wetland Inventory classification; gradient; aspect; air and water temperatures; depth; flow; percent overstory vegetation; substrate; and instream cover.

Measurements will be taken for all amphibians captured and include total length, snout-vent length, life stage, sex (when possible), and number of individuals.

Although amphibians are the focus of aquatic surveys, these habitats will also be searched for reptile species.

Terrestrial surveys in MORA

The target special status species to be inventoried in MORA include P. vandykei and P. larselli. A combination of probabilistic and non-random sampling will be used to maximize the likelihood of documenting the most species by visiting the best habitats. The probability sampling for terrestrial species will involve using a systematic grid, placed over areas that include the best suitable habitats delineated, with a random starting point to distribute samples across the landscape. Constraints will be placed on the random selection process to grid points that fall below 5500 ft and for which a safe access route can be found.

Terrestrial amphibian surveys will utilize the OLYM sampling design (Bury and Adams 2000). A 300 meter by 300 meter cluster will be divided into four plots, each with a 30 m radius. Plot centers are spaced approximately 200 meters apart.

In addition, a subset of samples in a variety of biogeographical areas thought to contain the target species will be selected a priori based on the field experience of amphibian experts. Examples of habitats that are most productive for detection of P. larselli include rocky substrates (gravel dominated soil to scree); late seral stands (Western Hemlock Zone and Western Hemlock to Pacific Silver Fir transition zone) on slopes greater than 70%; various aged forest stands growing on gravel or cobble dominated soil; and elevations from 2000 to 4000 feet. Examples of habitat that are most productive for detection of P. vandykei are seeps; waterfalls; first order streams and associated splash zones; and elevations between 2000 and 5000 feet.

Sample size for non-random and random strata will be determined after results of the OLYM terrestrial amphibian survey is complete.

Although *Rhyacotriton cascadae* is an aquatic species, it is often found in habitat similar to *P. vandykei.* Therefore the methods described above should also allow for detection of this species.

Surveys for terrestrial species will be conducted from May through August.

Lentic Surveys in MORA

The target special status species to be inventoried in MORA is *Bufo boreas*. The sampling design used in the past parkwide amphibian surveys was not optimal for locating this species. Potential habitat will be identified in the five major drainages in the park, using the recently corrected National Wetland Inventory maps (Samora et al., in prep B) . All lacustrine and

palustrine wetlands with depths of standing water over 0.5 meter will be identified within each drainage. An equal number of sites will be selected from each drainage and stratified based on NWI Class (Cowardin et al., 1979), size and elevation. Inaccessible and extremely remote sites will be excluded from the sampling universe. A maximum of 40 sites will be randomly selected for inventory due to length of season, time, and funding available for these inventories. Surveys will be conducted during the breeding season, from late May through July, depending on weather and snowmelt conditions.

Lotic Surveys in NOCA

The distribution and abundance of special status amphibians breeding in lotic systems will be inventoried at NOCA in drainages that have not been sampled (Chilliwack, Baker River, Goodell Creek, and Newhalem Creek). Using the park GIS, permanent headwater streams within these drainages will be included in the sampling universe with some exceptions. Due to the difficulty of working in remote and steep terrain, the sample universe will be confined to all accessible areas within 2.0 km from roads and trails. Backcountry sites will be sampled up to 20 km from trailheads. Permanent headwater systems are defined as 1st or 2nd order streams with continuous surface flow. The stream must have an average wetted width of $\leq$ 5 m at the lowest portion of the hydroperiod (i.e., mid to late summer). Twenty streams will be selected within each drainage and stratified by elevation and stream order.

For each 100 m of stream, 10 stream meters will be randomly selected as described in Bury and Adams (in prep). Amphibian surveys will be conducted in a 1 m wide "belt" transect placed perpendicular to the main channel at each of the 10 sites. Although area surveyed (m^2) will depend on the wetted width of the stream, all surveys will examine ~10% of the available area within the 100 m section of stream. By incorporating randomized sampling, predominant habitats should be sampled proportional to their availability. Surveys will be conducted from August through September.

Lotic Surveys at MORA

The target undocumented species in lotic systems in MORA are *Rhyacotriton cascadae* and *Dicamptodon tenebrosus*. Park funding will be used to attempt to document presence absence of these species, in association with other ongoing projects. Sampling will be non-random and opportunistic, based on time available to incorporate this effort into ongoing projects. These data will not be used to make inferences to other areas of the park. These surveys will be conducted from late July through September.

Survey Time

Amphibian surveys in NCCN parks, with the exception of NOCA, will be conducted within one year to maximize use of staff and available funding. Sufficient funding is not available to account for year to year variations. However, in all cases, early spring through summer reproductive periods will be represented. This will require three separate site visits to FOCL, FOVA, EBLA, and SAJH. Terrestrial and aquatic surveys will be conducted from mid-May

through July at MORA, depending on snowmelt and weather conditions. Aquatic surveys will be conducted in lotic systems in NOCA during August and September.

Survey Implementation

Dr. Michael Adams, USGS Forest and Rangeland Ecosystem Science Center, will provide overall technical direction for the inventory work. He will be responsible for summarizing the data and will have the lead role in producing the reports. NPS (Samora and Brokes) will be responsible for hiring, supervising, and directing the fieldwork as well as assisting in preparation of the final reports.

Summary of Amphibian and Reptile Inventories for Network Parks.

Park	**Verification Status**	**Inventory Tasks**
MORA	86%	Distribution and Abundance of Terrestrial Amphibians (focus on special status and undocumented species) Species Presence (focus on *B. boreas*, special status species and undocumented species)
NOCA	100%	Distribution and abundance of Aquatic Amphibians (lotic systems) and reptiles
FOCL	26%	Species Presence
FOVA	0%	Species Presence
SAJH	40%	Species Presence
EBLA	0%	Species Presence
OLYM	100%	Addressed under Declining Amphibian and other funding sources

Schedule.

	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH
2001							
2002	x	x	x	x	x		x
2003					x		
2004							
2005							

Budget

Budget Overview

Objective	Location	Inventory Funds	Park Matching Funds (ONPS)	LTEM Funds
1. Species Lists	SAJH, EBLA, FOCL, FOVA	$ 44,400		
2. Distribution	NOCA	$20,000	$11,100	$22,700
2. Distribution	MORA	$17,600	$31,012	$20,000
Totals		$82,000	$42,112	$42,700

Budget Itemization

Personnel	Species Inventory Funds	Park Matching Funds	
		ONPS	LTEM
MORA Biologist (GS-12) for 2.5 pay periods		$6575	
NOCA Aquatic Biologist (GS-12) for 1 pay period		$2630	
1 Supervisory Bio Tech (GS-07) for 10 pay periods (term appointment)	$14,820		
1 Supervisory Bio Tech (GS-07) for 9 pay periods (term appointment)		$12,237 (MORA)	
4 Seasonal Bio Techs (GS-06) for 16.5 pay periods	$24,090		$42,700
1 Seasonal Bio Tech (GS-06) for 3 pay periods		$3345(MORA) $2970 (NOCA	
BRD Research Ecologist (GS-12) for 2 pay periods	$5,000		
BRD Biologist (GS-7) for 8 pay periods	$9,950		
3 Student Interns @ $2500	$5,000	$2500 (MORA) $4000 (NOCA)	
Housing for Interns		$2700 (MORA) $1000 (NOCA)	
GIS Support (GS-12) for 1 pay period		$2500 (MORA)	
Travel			
NPS Travel	$11,550		
BRD Travel	$300		
Vehicles			
Small Park Crew			
1 @ $800/month for 3 months	$2,000		
2 @ $400/month for 5 months	$4,000		
Supplies/Equipment	$5,290	$4500 (MORA) $500 (NOCA)	
Totals	$82,000	$42,112	$42,700

Products

- Final Technical Report for each park.
- Checklists of verified species, that includes data on distribution and habitat for all species in small parks and distribution and habitat for special status species in MORA and NOCA
- Verification documents for all species at each park where those species are currently undocumented.
- Recommendations for a proposed sampling scheme to be used at Pacific Northwest parks for long-term ecological monitoring of amphibians.

Project Title: Fish Inventory for the North Coast and Cascades National Park Network

Program Leads: Reed Glesne, NOCA; John Meyer, OLYM; Dr. Steve Fradkin, OLYM; Barbara Samora, OLYM

Problem Statement

Fish populations of OLYM, NOCA, and MORA are of major sociological and economic importance, and contribute to many commercial, tribal, and recreational fisheries. Significant fish populations and habitat are not found in the smaller parks of the network (EBLA, FOCL, FOVA) although, the intertidal waters of SAJH may provide important habitat to a number of marine species.

A variety and abundance of aquatic habitats capable of supporting fish populations are found within the three large parks of the North Coast and Cascades NPS Network. Lentic habitats range from large natural lakes and impoundments to small alpine lakes and ponds. Lotic habitats include mainstem and tributary rivers of many Washington Coastal, Puget Sound, Columbia River, and the Fraser River Watersheds. These waters support major populations of salmonids including all five species of Pacific salmon, kokanee salmon, steelhead, rainbow trout, cutthroat trout, bull trout, Dolly Varden, and mountain whitefish. Of these species, several evolutionary significant units or distinct populations segments of chinook salmon, sockeye salmon, and bull trout have been added to the Federal list of threatened and endangered species. Non-native salmonids introduced to these waters include brook trout, golden trout, lake trout, non-native strains of rainbow trout, cutthroat trout, steelhead, and pacific salmon species. A variety of non-salmonid species representing the families of Acipenseridae, Catostomidae, Cottidae, Cyprinidae, Gadidae, Gasterosteidae, Petromyzontidae, and Umbridae are also found in within waters of these NPS units.

Fish populations represent important ecological and socio-economic components of the region. Fish are primary predators in almost all aquatic habitats, affecting other individual species and communities through both competition and predation. Non-native fish introductions have been widespread, and in some lakes have severely altered the native community structure. Pacific salmon represent keystone species for Pacific Northwest streams, as they play a major role in returning nutrients from the ocean to freshwater habitats. Their abundance affects the distribution and health of many species of wildlife and riparian plants.

Fish populations within the region have been heavily impacted by widespread non-native fish introductions, by loss and degradation of habitat from logging, hydropower development and non-point source pollution. In addition fish have been subjected to over-exploitation in commercial, tribal, and sport fisheries. Harvest management demands are continuing to compound threats to salmonid stocks utilizing these waters. Knowledge of the distribution and status of fish populations in the network parks is of critical importance to sustaining the native populations over time. Recently, Puget Sound chinook salmon and Lake Ozette sockeye salmon, and bull trout throughout their range, have been listed as a Federal-Threatened species. Westslope (*O. clarki lewisi)* and coastal cutthroat trout (*O. clarki clarki*) have been considered as candidate

species for Federal listing. The abundance of discrete stocks of native cutthroat and bull trout within the park boundaries is currently unknown and is not being monitored.

Very little survey and management emphasis has been placed on non-game fish species. These species are generally unaffected by exploitation but some, such as the Olympic mudminnow in OLYM are at risk form habitat alterations on lands surrounding the park as well as predation by non-native species of fish. Management efforts enhancing native sport fish and commercial fish populations and non-native species and strains may induce increased predatory and competitive stress. Conversely, declining populations of native species may allow species-specific expansion of some non-game fish to the detriment of other non-game and/or game fish species.

In general, the distribution of native indigenous fish species within the network parks has not been well delineated. Distribution data exists for some rivers, streams, and lakes, but much of what exists is old data and/or is not applicable in the assessment of relative abundance or population status. In addition, there is practically no information concerning marine species inhabiting intertidal waters of OLYM and SAJH.

Objectives

The primary inventory focus of this proposal is on stream fish populations with the following goals:

1) To provide a basic inventory, at the 90% completion level, of all fish species found within the North Coast and Cascades NPS Network.
2) To develop sampling designs, protocols, and QA/QC plans for both inventory and future monitoring in the network parks.
3) To determine general fish species distributions (native and non-native species) within MORA, NOCA, and OLYM.
4) To determine distribution and relative abundance of bull trout/Dolly Varden and cutthroat populations within MORA, NOCA, and OLYM.

Strategy

The general strategy is to first, update verification of species occurrence in all of the network parks to the 90% level. Secondly, develop a probabilistic sampling design, review and test fish distribution and relative abundance sampling protocols that would function for future monitoring of status and trends of stream fish populations. Finally, complete sampling protocols and QA/QC procedural manuals and implement distribution and relative abundance surveys in NOCA, MORA, and OLYM.

Objective 1 - Update species occurrence information for MORA, OLYM, FOCL, and SAJH to 90% level.

Several freshwater fish species at MORA and FOCL, and most marine intertidal zone fish species at OLYM and SAJH still require verification of their presence in these park units. The focus of FY2001 efforts will be directed at meeting this objective.

MORA

The headwaters of several Puget Sound drainages (White, Puyallup, and Nisqually) and a Columbia River tributary (Ohanapecosh) originate in MORA. Those portions occurring in the park are primarily comprised of steep gradients and most are highly influenced by glacial turbidity. Park staff has conducted some sampling of fish in these drainages, directed primarily toward ESA and NEPA compliance. These surveys have revealed trout, sculpins, and bull trout or Dolly Varden. The US Fish and Wildlife Service listed bull trout as a threatened species on November 1, 1999. Distinguishing between bull trout and Dolly Varden requires DNA analysis, which has not been done, and sculpins have not been keyed out to species. Some anadromous salmonids (probably spring chinook salmon and steelhead trout, but possibly coho salmon and cutthroat trout) also utilize park rivers.

During FY2001, fish sampling in MORA will focus on a variety of stream habitats using several sampling techniques to primarily document occurrence of unverified fish species in the park. Sampling sites will include sections of mainstem rivers and large tributaries with gradients of 8% or less and which are safely accessible. Prioritization of sampling sites will be based on previous information and knowledge concerning possible distribution patterns of species expected to occur but not yet documented. Electrofishing, angling, minnow traps, and, when water visibility allows, snorkeling and foot surveys will be employed. Since bull trout and Dolly Varden can only be reliably identified through DNA analysis, non-lethal fin clips will be removed from all native char captured and delivered to the Washington Department of Fish and Wildlife for genetic analysis.

FOCL

Fisheries habitat is limited at FOCL with the exception of its border along the lower Lewis and Clark River. During FY2001, Fisheries staff from OLYM will conduct field surveys to document fish species presence in the section of the Lewis and Clark River that borders the park. Additional efforts will be made to obtain information from the Oregon Department of Fish and Game for documentation of fish species presence in the vicinity of FOCL.

OLYM and SAJH

OLYM and SAJH include diverse intertidal habitats spanning a range of physical environments that are representative of the open coast and Puget Sound. The objective of this work is to document the presence of 90% of marine fishes expected to occur within the intertidal areas of OLYM and SAJH.

The 65 miles of outer coast that make up the OLYM coastal strip is composed of diverse habitats (i.e. sand, gravel, cobble and boulder beaches, rocky platform, ramp, and cliff substrates, persistent tidepools, abbreviated estuaries) exposed to a high-energy physical environment typical of the open coast. These diverse habitats support a rich assemblage of marine fishes that play an important role in structuring intertidal food webs. The present intertidal monitoring program at OLYM does not include marine fish, and very little data exist on OLYM marine fish.

Most information is anecdotal and related to the harvest of recreational sport fish (e.g. surfsmelt, surfperch, rockfish). Baseline data on fish species presence/absence are needed.

The intertidal areas of SAJH are associated with its two units, English Camp and American Camp. The English Camp coastline (~1.5 miles) is within Wescott and Garrison Bays, and is protected from Puget Sound. The intertidal zone is shallow and flat with a sand/mud bottom. The American Camp coastline (~4.5 miles) is exposed to Puget Sound, and consists of rocky coves, sandy lagoons, and sandy beaches. Some data on SAJH intertidal fish exist (e.g. Univ. of Washington), however it is not necessarily concentrated in a single source and its quality and completeness is unknown.

Intertidal inventories involve surveying shallow waters overlaying intertidal substrates. Fish species have associations with specific habitats, many of which have complex substrate structures due to geologic formations and algal canopies. Different fish life-history stages (i.e. adult, juvenile, larval) may also occupy intertidal habitats on different temporal scales (i.e. day/night, seasonal). The sample design will incorporate these considerations by employing an array of sampling techniques over relevant temporal scales. Inventory work will proceed in five phases: 1) historical data gathering; 2) sampling protocol design; 3) technique feasibility analysis; 4) field inventory work; 5) laboratory ID and voucher preparation.

All representative habitat types will be survey, where feasible, for species presence/absence. Quantitative abundance and distribution data cannot be gathered due to habitat complexity and logistical constraints. However, qualitative abundance estimates and habitat-related distribution data will be collected.

Inventorying fish in Pacific Northwestern intertidal habitats is challenging, and no standardized protocols exist. Some techniques suggested below were proposed at an inventory and monitoring workshop conducted by the Mediterranean Coast Network (CABR, CHIS, SAMO) in 1999. Sampling techniques to be explored for use at OLYM and SAJH include beach seines, fish traps, SCUBA/snorkel surveys, video surveys, tidepool draining/anesthetization (CO2), hook and line surveys, corrals/weirs, electroshocking (Davis and Anderson, 1989), icthyoplankton nets, and light traps. The latter two techniques will be employed to sample larval fish.

Inventorying will be initiated at OLYM where sample design and technique feasibility will be established. After a satisfactory design is determined, work will begin at SAJH. Both inventories will be conducted by OLYM staff. The full suite of sampling techniques will be examined on the more challenging coast of OLYM. Representative habitat types will be sampled day/night and seasonally (late spring and summer FY2001, fall FY2002) where feasible. A more limited sampling effort will be conducted at SAJH reflecting its small coverage area, fewer habitat types, and relatively benign physical environment. SAJH habitats will be sampled day/night and seasonally as above, where feasible. English camp is a protected flat bay. This area will be sampled via beach seining, icthyoplankton nets, and light traps. American Camp is composed of rocky coves, sandy beaches and lagoons. This area will be sampled via SCUBA/snorkel surveys, beach seining, icthyoplankton nets, and light traps.

Fish families expected to be seen in OLYM and SAJH intertidal areas include: Clupeidae, Osmeridae, Ammodytidae, Salmonidae, Gasteosteidae, Aulorhynchidae, Synshathidae, Trichodontidae, Emiotocidae, Gobiidae, Clinidae, Pholidae, Cryptacanthodidae, Hexagrammidae, Cottidae, Agonidae, Bothidae, Gobiesocidae, Liparidae

Objective 2 - Develop sampling designs, protocols, and QA/QC plans for distribution and relative abundance surveys of stream fish populations at NOCA, MORA, and OLYM.

During the first year of the program, statistical consultants, park aquatic resource staff, and other cooperators would develop sampling designs, and review existing fish sampling protocols. Field pilot surveys would be conducted to determine initial variance estimates for the selected methods, if survey data and/or literature concerning sampling variance is not available. In the second year of the program, final protocols, QA/QC and data analysis procedures will be finalized and inventories implemented (note - Network monitoring funds will be used for completion of Objective 2).

Funding under the current inventory program may not be sufficient to complete all fish species inventories resulting in discontinuous data collection efforts. Therefore, it is important that the sampling design be flexible in its ability to partition sampling effort while maintaining desirable design characteristics of inference, and utility of data for future comparisons. A systematic sampling design such as proposed by Overton and McDonald (1998) for estimation of juvenile coho in streams of Northern California and Southern Oregon may provide a model for our network effort. A major advantage of their design is in the flexibility of ordering stream sample segments, which allows separate estimates for sub-basins and also ensures spatial coverage of the sample.

It is expected that two levels of survey will be required. The first level represents an extensive type survey that focuses on collection on multi-species presence/absence type data. Sampling design considerations must also permit intensified surveys (with spatial and seasonal coverage) for target species such as bull trout and cutthroat trout. For example, primary fish habitat in NOCA is largely represented by streams with gradients less than 4%, although some significant habitat for bull trout is found in stream segments with gradients between 4 to 8%. A general species presence/absence survey may define all segments with gradients less than 4% as the criteria for defining if a stream segment is included in the sample universe. In sub-units where knowledge of bull trout distribution and relative abundance are required, a subset of segments with gradients between 4 and 8% would also require sampling.

Fish sampling efforts will use snorkeling protocols such as those developed by Bonar et al. (1997), Hankin and Reeves (1988), Hillman and Platts (1993), and Thurow (1994). Other methods, such as nets, traps, and electrofishing, may be necessary in streams with conditions not amenable to snorkeling. Additional stream physical characteristic attribute data concerning channel morphology, large woody debris, substrate, and habitat units may also be collected using Level II stream inventory protocols developed by the US Forest Service - Region 6 (1999) or the Timber-Fish-Wildlife Ambient Monitoring Program (Schuett-Hames et al., 1994).

Objective 3 – Implement sampling protocols to determine distribution and relative abundance of stream fish populations at NOCA, MORA, and OLYM.

Following completion of Objective 2, inventory funds will be used during FY2002 and FY2003 to conduct stream fish surveys to delineate distribution and relative abundance at NOCA, MORA, and OLYM. It is expected that inventory needs will require additional funding over what is available in the NPS Bio-inventory program. There are approximately 500+ total stream miles for NOCA, MORA, and OLYM , that fall within the 0 to 8% gradient category. The protocol for determining bull trout presence (Peterson et al. 2000) would require sample sizes that approach 30 % of the available habitat (150 miles). For other species sample sizes of less than 25 % may not be satisfactory. Given a total of 500 stream miles and assuming a cost of $2500 to $3000/mile surveyed (NOCA estimate from past fish survey work) - it would cost approximately $312,000 to $375,000 to survey the 500 miles at a 25% sampling effort (125 miles). FY2002 and 2003 funding will allow sampling of a total of 35 to 45 miles of habitat (less than 10% of the available habitat). In order to maintain a sufficient amount of effort in any given basin or sub-basin, it will be necessary to develop sampling priorities. Parks may focus first on watersheds that have little baseline information or watersheds with special interests such as those that require determination of bull trout presence or absence, or other priorities. Additional future efforts and continuity of sampling programs will be dependent of funding support at individual parks or through the network monitoring program.

Schedule

Activity	FY01	FY02	FY03
Objective 1.			
Update freshwater fish species lists to 90% level at MORA and FOCL.			
Update marine intertidal fish species lists to 90% level at OLYM and SAJH.		complete by Jan	
Objective 2.			
Sample Frame Development (following Overton and McDonald, 1998 - conceptual definition, universe delineation, segment identification, identification of estimation domains, assignment of segment identifiers)			
Sample Selection (following Overton and McDonald, 1998 - ordering the frame, selection of systematic sample)			
Review and evaluate fish sampling protocols.			
Select fish sampling protocols and conduct pilot studies to determine initial variance estimates.			
Finalize protocols including data analysis, data management and QA/QC procedures.		complete by May	
Objective 3.			
Conduct stream resident fish distribution surveys at NOCA, MORA, and OLYM			

Budget

Budget Overview

Objective	Location	Species Inventory Funds	LTEM Matching Funds
1a. Species Lists – Stream fish	MORA, FOCL	$11,000	
1b. Species Lists – Intertidal Fish	OLYM, SAJH	$31,200	
2. Develop sampling design & protocols – stream fish	NOCA, OLYM, MORA		$34,000
2. Distribution & abundance of stream fish populations	MORA, NOCA, OLYM	$110,800	
Total Funding		$153,000	$34,000

Budget Itemization

Objective	Species Inventory Funds			LTEM Matching Funds	
	FY01	FY02	FY03	FY01	FY02
Objective 1A. - Meet 90% stream fish species verification levels at MORA and FOCL[1].					
Salaries and Benefits (GS5 and GS7 for 4pp each)	$9,200				
Travel and Per Diem	$1,000				
Vehicles	$500				
Equipment					
Misc. Supplies	$300				
Subtotal Obj. 1A	$11,000	-0-	-0-	-0-	-0-
Objective 1B. - Meet 90% marine intertidal fish species verification levels at OLYM and SAJH.					
Salaries and Benefits[2]	$16,100	$6,900			
Travel and Per Diem	$700	$300			
Vehicles	$800	$400			
Equipment (nets, dry suits, snorkel gear, camping gear)	$5000				
Misc. Supplies	$700	$300			
Subtotal Obj. 1B	$23,300	$7,900	-0-	-0-	-0-
Objective 2. - Develop sampling design and protocols for stream fish distribution and relative abundance. (NOTE - Network monitoring funds will be used for completion of Obj. 2)					
Salaries and Benefits[3]				$19,800	
Travel and Per Diem[4]				$2,000	
Statistical Consultant[5]				$7,500	$2,000
Vehicles				$800	
Equipment (waders and dry suits)				$1,500	
Misc. Supplies				$500	
Subtotal Obj. 2				$32,100	$2,000
Objective 3. - Determine distribution and relative abundance of stream resident fish populations at NOCA, MORA, and OLYM.					
Salaries and Benefits[6]		$46,400	$46,400		
Travel and Per Diem		$1,500	$1,500		
Vehicles (3 vehicles total for field season at each park)		$3,000	$3,000		
Equipment (waders, dry suits, misc sampling gear)		$3,000	$3,000		
Misc. Supplies		$1,500	$1,500		
Subtotal Obj. 3	-0-	$55,400	$55,400	$32,100	$2,000
Annual Totals	$34,300	$63,300	$55,400		
Grand Total – Species Inventory	$153,000				
Grand Total – Matching LTEM Funds				$34,100	

[1]OLYM staff will conduct surveys at FOCL, with only $500 from travel and per diem category required.
[2]GS5 and GS7 for 7pp in FY01 and 3pp in FY02.
[3]Two GS5 and one GS7 Techs for 6pp.
[4]Travel costs are based on crew of 3-4 people visiting each of the three large parks for conducting pilot studies.
[5]Assistance and travel for sampling design and data analysis protocols.
[6]Two GS5/6 Techs at each of MORA, NOCA, and OLYM for 6pp during FY2002 and FY2003. One GS7 Tech at MORA for 8pp during both FY2002 and 2003.

Products

- Species list of fish species, verified at the 90% level, for MORA, OLYM, SAJH, and FOCL
- Recommendations for development of sampling designs and methods for inventory of intertidal fish species in OLYM and SAJH.
- Development of sampling designs, protocols, and QA/QC plans for distribution and relative abundance surveys of stream fish populations at NOCA, MORA, and OLYM.
- Report and GIS maps and data attribute files describing the distribution and relative abundance of stream resident fish populations at NOCA, MORA, and OLYM.
- Final technical report on species occurrence in all parks and recommendations for long-term monitoring protocols.

Project Title: Vascular Plant Inventories and Distribution

Program Leads: Dr. Regina Rochefort, NOCA; Laurie Kurth, MORA

Problem Statement

Vascular plant communities are an important component of National Park biodiversity. Operationally, vegetation characteristics such as dominant plant species, canopy cover, or stand age are often used to classify landscapes prior to identification of management zones or development of management plans or as a stratification level in research projects and long-term monitoring programs. Functionally, plants influence hydrologic and biogeochemical processes, nutrient cycling, disturbance patterns, and patterns of human use. In long-term monitoring programs, plants are valuable indicators because they reflect current and past environmental and climate factors and the influence of stressors to ecosystems. Plant species composition is easy to monitor and as an integrator of environmental influences may change more rapidly than individual environmental factors (Leak, 1992; Philippi et al., 1998).

The first step in developing a long-term monitoring program is identification of ecosystem components. Although plants are one of the most recognized ecosystem components in many national parks, only two of our network parks had complete vascular plant inventories (FOCL and MORA). Two parks (NOCA and OLYM) had regional floras that were used as species lists, and the remaining three parks (SAJH, FOVA, and EBLA) had plant lists limited to management concerns (exotic species) or specific research projects (e.g. forests of San Juan Island as reported in Agee, 1987). Although Mount Rainier and Olympic have extensive herbaria collections, research data, and literature, this data is not readily accessible. Our study plan seeks to complete the first step in the development of long-term monitoring programs for each park (i.e. verified species lists), collect detailed information for management of introduced and sensitive species, and organize existing data to facilitate vital signs scoping session and development of long-term monitoring programs.

Objectives

The objectives of the vascular plant proposal are:

1) Complete verification of 90% of vascular plants expected to occur in all network parks.
2) Develop quantitative assessments of invasive, exotic species and the habitats in which they occur.

Objective1: 90% Verified Species Lists

Strategy

Verification of plant species lists will be accomplished through data mining and fieldwork. Data mining will include literature searches, inventories of local herbaria, compilation of park databases, and inventories of databases held by other agencies (e.g. Washington Natural Heritage Office). Field surveys will include complete inventories of plants in parks with small acreage (e.g. Fort Vancouver National Historic Site), surveys of under-surveyed habitats, and surveys of

potential habitats for listed plant species. Descriptions of work to be performed in each park are detailed below.

Fort Vancouver National Historic Site

Fort Vancouver National Historic site encompasses 170 acres including both intensively landscaped and "natural" areas. Previously, the only plant inventories that had been conducted were an inventory and map of 300 ornamental trees, descriptions of historic vegetation (Taylor and Erigero, 1992), and lists of exotic species compiled by park staff (Myers et al., 1996). From these lists, we found 60 vascular plants species to input into NPSpecies databases. Due to the manipulated nature of most of the landscape, we did not feel that compiling a master list of expected plants would be very helpful. We decided that a master list would best be compiled and verified by field surveys. Due to the small size of the park, complete area searches were planned and initiated in the fall of 2000. The park was divided into four zones reflecting habitat and park management: Columbia River, East of the Fort, South and East of the airport, and the Orchard. The Columbia River zone is located on the south boundary of the park and contains shoreline, stabilized banks, walkways, and lawns. The area east of the Fort contains primarily manicured areas such as historical gardens and mowed pastures. The area south and east of the airport contains large areas of black cottonwood (*Populus trichocarpa*) and the exotic Himalayan blackberry (*Rubus discolor*).

Inventories were initiated in September 2000 through a contract with a local consulting company (Robson Botanical Consultants, see Appendix 5). Surveys conducted in September and October have concentrated on verification of tree species and fall flowering species (primarily exotic species). All species are documented by abundance class, using NPSpecies categories, for the park and for each management zone. Voucher specimens have been collected for all difficult to identify species, species of management concern (introduced), and common native species. To date, approximately 80 species have been documented and 20 voucher specimens pressed. Pressed plants will be mounted by volunteers from the local Garden Club under the supervision of the Dr. Robson (contractor) and Greg Fauth, Chief of I&RM (FOVA). Plant lists will be completed by August 2001 through spring and summer field surveys.

Mount Rainier National Park

Plant lists at Mount Rainier have been verified at 89% through inventories of the park herbaria, collections at University of Puget Sound and Skagit Valley College, and partial surveys of University of Washington and Western Washington University. Plants species documented in park databases and in scientific studies have not yet been entered into NPSpecies. We plan to complete 90% verification through inventories of park databases, scientific studies, and completion of surveys of herbaria at University of Washington, Western Washington University, and Pacific Lutheran University.

Additionally, field surveys are planned to verify the occurrence of state listed plant species that have potential habitat in the park (Table 6). During the winter of 2000, we consulted with John Gamon, (Washington Natural Heritage Program Botanist) to develop park-specific species lists of listed species. We also received digital copies of all state data on listed species. During

FY02, literature searches will be completed on each species to identify GIS attributes that can be used to develop potential habitat maps for their occurrence. Field surveys will be completed during the summer of 2002 and all data will be shared with the Washington Department of Natural Resources. Our goal is to thoroughly search potential habitats, refine our search image of suitable habitats for each species, and document population status and size on all located species. We will also document all potential threats to each population.

Table 6. Listed Plant Species and General Locations in Mount Rainier National Park.

Scientific Name	**State Status**	**Collection Locations**	**Date**
Agoseris elata[1]	S	no records	
Botrychium lanceolatum	S	"Mt. R. NP", no other data (Univ. Puget S.) Paradise	no date 1988
Botrychium lunaria	S	"Mt. R. NP", no other data (Univ. Puget S.)	no date
Carex atrata	S	"common on Mt. Rainier"	1995
Carex atrosquama	S	no records	
Castilleja cryptantha	S FC	27 known locations including: Frozen, Lake,Yakima Park, Grand Park, Mystic Lake, locally abundant	2000 1978 1966 1934 1928
Dryopteris cristata	S	no records	
Galium kamtschaticum	S	Goat Island Mountain	1992
Luzula arcuata	S	no records	
Microseris borealis	S	no records	
Pedicularis rainierensis	S	Abundant throughout subalpine meadows, Paradise Hidden Lake	 1988 1988
Poa nervosa	S	no records	
Polemonium viscosum	S	Goat Island Mountain	1996
Saxifraga debilis	S	"Mt. Rainier"	1995

Species in bold print will be the focus of field surveys
S = sensitive species, FC federal species of concern

North Cascades National Park Service Complex and Olympic National Park

Master lists from North Cascades and Olympic National Parks were based on regional plant lists. In each case, local experts were asked to revise the lists by removing plants that would not be expected to occur in the park and adding species or habitats that were not adequately represented on the lists. In the case of OLYM, the species list is currently verified at 70% through inventories of park herbaria and herbaria mentioned in the Mount Rainier section. Local botanists and park personnel felt that if inventories were conducted of the remaining collections and scientific literature, the current list would probably be verified at 90%. However, it was agreed that coastal wetland plant species were not listed on the master list and field surveys would be necessary to add these species to the list and verify their occurrence.

Olympic National Park Field Surveys

Olympic National Park contains over 60 miles of pristine, unfragmented pacific coastline, the largest section of wilderness coast in the lower 48 states. This area harbors some of the best examples of Pacific coastal bogs and wetlands in Washington State. Known for impenetrable vegetation, this is one of the most under-surveyed areas in the park. Previous studies have documented a high proportion of rare vascular plants in the coastal region of the park. Consequently, the likelihood that species new to the park will be discovered during thorough surveys of this area is great. The region is well-known for several coastal endemic species (e.g. *Gentiana douglasiana* and *Carex macrocephala*) and as recently as 1998, *Coptis trifolia*, a bog taxa new to Olympic National Park and the lower 48 states was discovered in this area.

Nineteen palustrine wetlands identified on National Wetland Inventory maps have been targeted as accessible for species inventories. Utilizing the NWI wetland classification system (Cowardin et al., 1979), these wetlands have been identified to subclass and represent five classifications. Three classes are represented by just one wetland and two have multiple wetlands:

Wetland Type	**Number of Wetlands**	**Average size (s.d.) (ha.)**
Palustrine forested, needle-leaved evergreen	6	17.7 (9.8)
Palustrine forested, needle-leaved evergreen/broadleaved deciduous	10	6.3 (6.5)
Palustrine, open-water	1	2.2
Palustrine, scrub-shrub, broadleaved deciduous	1	3.7
Palustrine, scrub-shrub, needle-leaved evergreen	1	2.3

Inventories will be completed using area-wide searches based on an "intuitive-control" approach. In the case of the larger wetlands, the surveyors will walk transects across the wetland to insure that all hydroperiods in the wetland are surveyed. All transects will be mapped using a GPS in the event that they are revisited. Abundance of each species will be recorded using the categories used in NPSpecies; all rare species will be mapped and documented using a local (network-wide) modification of the Washington Natural Resources data sheet. All wetlands will

be surveyed at least twice during the field season (May – September) to insure documentation of all species. Voucher specimens will be collected for all difficult to identify species (grasses, sedges, and rushes) and as time permits, additional species when populations are large enough to support removal of several specimens. All vouchers will be deposited in the Olympic National Park herbarium. Unique and uncommon species will be photographed for documentation. All wetland types represented by one site will be surveyed. Samples within the remaining two types will be randomly selected and numbers of sites surveyed will be determined by species/area curves.

Rare plant surveys at Olympic National Park will follow the same protocols as those in Mount Rainier National Park. Surveys will focus on nine species that were recorded in the park, but have not been observed for over 25 years. Historic locations will be searched as well as potential habitat identified with the park's GIS.

Scientific Name	**Common Name**	**Status**	**Location**
Arnica cordifolia var. *pumila*	Heart-leaf arnica	Park species of concern	Mt. Angeles, 1936 Sentinel Peak
Botrychium simplex var. *simplex*	Little grapefern	State sensitive	Skokomish area, 1890
Carex praticola	Meadow sedge	Park species of concern	Ozette Lake, 1950
Clarkia purpurea ssp. *quadrivulnera*	Small-flowered clarkia	Park species of concern	Angeles/Elwha area, 1900
Epilobium oregonense	Oregon willow-herb	Park species of concern	Skokomish area, 1890 Seven Lakes Basin, 1936
Lactuca biennis	Tall blue lettuce	Park species of concern	Lake Crescent, 1936
Mimulus primuloides var. *primuloides*	Primrose monkey-flower	Park species of concern	Heather Park, 1941
Silene menziesii ssp. *menziesii*	Menzies' silene	Park species of concern	Angeles/Elwha, 1900
Trimorpha acris var. *kamtschatica*	Bitter trimorpha	Park species of concern	Mt. Angeles

North Cascades National Park Service Complex Field Surveys

North Cascades National Park Service Complex has been the focus of very few botanical studies (13 listed in NRBIB). Dorothy and Ralph Naas (1990) compiled the list with assistance from George Douglas for the North Cascades ecosystem. Originally the list contained 1,910 species, but was reduced to 1,627 species based on review by Dorothy Naas, and John Gamon of the Washington Natural Resources office. This year, all herbaria records from NOCA, University of Puget Sound, and Skagit Valley College and all documentation from plant studies were entered into the NPSpecies databases. Currently 529 species have no verification within the park. This list includes 73 species listed by the Washington National Resources Office as species of concern. Only 17 of the 73 species have been documented within the park (Appendix 6). Field surveys will be conducted in FY01 and FY02 verify the park's species list at the 90% level. Two

types of field surveys will be conducted: surveys of rare species habitats and surveys of under-surveyed habitats.

Potential habitats will be identified using the park's GIS for all species with a state rating of Endangered (2 spp.), Threatened (4 spp.), and Sensitive species for which habitat maps can be developed. We will work with the Washington Department of Natural Resources to refine habitat predictions and search methodologies. Literature searches and GIS mapping will begin in FY01 and field surveys in FY02.

Literature surveys are currently in progress for the 529 undocumented species on the park Master list. Prior to the initiation of these surveys, Dorothy Naas had estimated that the "under-surveyed" areas of the park were subalpine and alpine areas and wetlands (particularly high-elevation wetlands). Our surveys agree with Mrs. Naas' initial assessment of "under-surveyed" areas within the park. Habitat characteristics for each species have been documented, by categories, for each species and show that 45% are subalpine, 25% are wetland species, 20% are from mid to low-elevation forests and the remaining 10% are found in disturbed habitats. Elevation range, aspect, canopy closure, soil type, and associated species have also been recorded for each species. These data will be with used to identify potential habitat with the park's GIS. We suspect that by surveying these areas, we will be able to verify recorded species and add new species to the park list. Voucher specimens will be collected for all unverified species.

Once under-surveyed areas have been delineated using the collected data and the park GIS, surveys areas will be selected randomly from all areas delineated. Whenever possible, sites will be co-located with bird survey sites in order to provide vegetation data for both study objectives. Field surveys will utilize both unconstrained searches (for small areas) and quantitative inventories using multi-scale plot sampling with randomly located plots in larger habitats. Sampling protocols will be developed during the winter of 2001 with assistance from Dr. Jean-Yves Pip Courbois (University of Washington, see Appendix 5).

During the first year of the study, several nested study plots will be tested (FIA, GLORIA in subalpine and alpine) to collect quantitative community data and begin identification of long-term monitoring protocols. Plots will be supplemented by visual searches of surrounding areas for species not encountered in the plot (both timed searches and fixed area searches will be experimented with).

<u>San Juan Island National Historical Site</u>

Currently, the master list for SAJH contains 648 vascular plants based on review of regional plant lists (Atkinson and Sharpe, 1993) and park resource studies (Agee, 1987; Holmes, 1998). This year (2000), David L. Peterson of the USGS, FRSC unit at University of Washington received funding for a Vegetation and Fuels Mapping project in the park. Data is currently being summarized and should be available by December 2000. In this project, 1:5,000 geo-referenced aerial photos were used to identify vegetation polygons. Approximately 67 polygons were visually identified and using color and texture patterns. All polygons were ground-truthed and categorized by dominant vegetation. Forest areas were identified using Agee's (1987) 12 forest

types. Meadows were classified as wet and dry, but rocky outcrops and wetlands were not classified or surveyed. All polygons were stratified by size into three size classes: small (<5 ha), medium (<10 ha), or large)>10 ha). Within each polygon, a 0.01 ha, circular plot was randomly located in the center of the area. All trees were measured and identified, all dominant shrubs (i.e. >10% cover) were identified and cover estimated by 10% cover classes. All other species were identified and listed. Grasses, sedges, and rushes were not identified in any area and field personnel did not conduct a complete survey of each polygon. Voucher specimens were not collected.

We will use data from Peterson's study to calculate species are curves for all forested areas. Based on these estimates, we will project sample sizes for forested areas. To develop species lists for forested areas, we will randomly select plots from Peterson's study to revisit for species verification, identification of grass and sedge species, and collection of voucher specimens. Species lists for meadows will also be developed by revisiting a random selection of Peterson's plots but since grasses were not identified initially in these sites, we expect calculations of species area curves may be very conservative.

In 1998, Holmes ground-truthed all wetlands in the park with funding from NPS water resources. All wetlands have been delineated on the parks GIS and classified to subclass. Routine jurisdictional vegetation surveys were conducted identifying dominant plant species. These data will be used to stratify wetland areas and a subset will be randomly selected for species surveys. There are 69 wetlands within the park representing 11 wetland types. Surveys of these areas will follow methods identified for Olympic National Park, but additionally may include quantitative plots for classification of wetland types. In this case, cover of all plant species will be estimated using the multi-scale vegetation plots randomly located within each wetland. Within each plot, canopy cover classes, soil type, and environmental data will be recorded. Data will be classified using multivariate analysis such as those included in PC-ORD. Wetland types documented in the park are summarized below.

Wetland Type	**Number of Wetlands**	**Average size (s.d.) (ac.)**
Palustrine forested, broadleaved deciduous	18	1.7 (1.7)
Palustrine forested, broadleaved deciduous – partially drained	2	11.7 (15.9)
Palustrine, scrub-shrub broadleaved deciduous	10	1.1 (1.1)
Palustrine, unconsolidated bottom, mud	1	0.55
Palustrine, aquatic bed, floating vascular	1	.31
Palustrine emergent, persistent	22	0.513 (0.7)
Palustrine emergent, persistent– partially drained	2	0.7 (0.6)
Palustrine emergent, nonpersistent	6	0.13 (0.13)
Estuarine, subtidal, unconsolidated bottom, cobles/gravel	2	5.04 (3.02)
Estuarine, intertidal emergent, persistent	3	3.2 (1.1)
Estuarine, intertidal, unconsolidated shore, cobble/gravel	1	.55

Rocky outcrops will be delineated on aerial photos and randomly selected for inventories. Since outcrops are generally very small in size, complete searches will be made of all areas and species recorded with abundance estimates. Nonvascular plants are an important component of these areas and samples will be collected for herbaria collections and identification.

Inventories will be conducted in the first year of the study to tie-in with Peterson's study and to provide identification of grasses and sedges to complete his study. All sites will be inventories two to three times during the season (May to September) to insure documentation of all species. Verification of state and federally listed species will be obtained through habitat-specific survey and based on recommendations by John Gamon (Botanist, Washington Natural Resources Office).

Ebey's Landing National Historical Reserve

Plant inventories at EBLA will focus on Fort Casey and Fort Ebey State Parks, Rhododendron County Park, all NPS lands (35 acres), and prairies owned by the Nature Conservancy. These areas comprise the largest expanses of undisturbed areas and most of the vegetation types within the Reserve. During 2001, we will continue to collaborate with state agencies, museums, the Natural Conservancy to compile species lists from available data. Species lists will be developed in conjunction with other taxa inventories as "bio-blitzes" in 2002 – 2004.

Survey Implementation and Logistics

Dr. Kali Robson will conduct plant inventories at FOVA under a small quantities contract. NPS seasonal employees will conduct all other surveys. Surveys at SAJH and NOCA will be conducted with shared crews under the supervision of Dr. Regina Rochefort, NOCA. Planning for these surveys will be conducted in January, 2001 by Dr. Rochefort and Laurie Kurth in collaboration with Dr. Ed Schreiner and Dr. David L. Peterson (USGS, FRESC). Dr. Jean-Yves Corbois will provide statistical advice regarding sampling design and data analysis (see Appendix 5). Rare plant and under-surveyed area inventories at OLYM will be conducted under the supervision of a Plant Ecologist on their staff. Rare plant surveys at MORA will be supervised by Laurie Kurth, the park's Plant Ecologist.

	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH
2001			x		x		x
2002				x	x		
2003	x					x	
2004	x					x	
2005							

Budget

Budget Overview

Objective	Location	Year of Inventory	Species Inventory Funding
Inventory under-surveyed areas	FOVA	2001	$4,000
	SAJH	2001	$19,000
	NOCA	2001, 2002	$19,000
	OLYM	2004	$17,000
	EBLA	2003, 2004	$5,000
Very Presence of Listed Plant Species	NOCA	2002	$19,000
	MORA	2002	$15,300
	OLYM	2004	$10,100
Total Inventory Funds			$108,400

Budget Itemization

Cost Category	Species Inventory Funding				Matching Funds (cluster funding)
	2001	2002	2003	2004	
FOVA- contract & travel	$4,000				
EBLA – personnel services			$5,000		
Survey SAJH and NOCA under-surveyed areas and NOCA listed species					
GS-07, term 10 pp each yr.– NOCA/SAJH	$15,160	$15,160			
GS-05 seasonal, NOCA/SAJH	$8,000	$8,000			
Per diem	$1,840	$1,840			
Vehicle	$2,500	$2,500			
Supplies	$1,000	$1,000			$1,000
Statistical Consulting					$2,000
Curatorial Support					$1,000
Total	$28,500	$28,500			
Survey OLYM under-surveyed areas and listed species					
GS-07, seasonal, 11 pp				$13,200	
GS-05, seasonal, 11 pp				$10,000	
Per diem				$1,900	
Vehicle				$1,500	
Supplies				$500	
Total				$27,100	
Verify MORA listed species					
GS-07, seasonal, 6 pp		$7,200			
GS-05, seasonal, 5 pp		$5,000			
Per diem		$900			
Vehicle		$1,200			
Supplies		$1,000			
Total		$15,300			

Products

- Verified Species lists for NOCA, SAJH, FOVA, EBLA, OLYM, and MORA.
- Population status and geo-referenced data for all listed species documented.
- Plant community descriptions of wetlands, rocky outcrops, and meadows for SAJH; these data will be combined with the Vegetation and Fuels Mapping Project to provide a comprehensive description of vegetation at SAJH.
- Refinement of vegetation plot protocols for use in long-term monitoring program (i.e. in collaboration with the Landbird Survey).
- Annual and final reports on plant species surveys in the network parks.

Objective 2: Develop quantitative assessments of invasive, exotic species and the habitats in which they occur.

Problem Statement

Invasive non-native plants threaten the natural ecosystem integrity and pose a significant threat to the unique and rare botanical resources that we aspire to protect in national parks in the Pacific Northwest. Twenty-five noxious weed species and more than two hundred and seventy other non-native species are present within National Park Service areas in the North Coast and Cascades network. Invading weeds threaten entire native plant communities and the wildlife they support. Several noxious weed species and species with a significant potential to invade and displace native communities are common to many of the network parks (Table 7). *Cytisus scoparius* (Scotch broom) poses serious threat in all parks in the network. Although presence/absence information is available for most of these species, few areas have been systematically inventoried and abundance/distribution information is lacking or limited to a few individual populations. Lack of quantitative inventories has recently been cited as a deficiency in efforts to receive funding for non-native plant control. The proposed survey will provide a quantitative inventory of noxious weed species on sites most susceptible to invasion.

Objectives

The objectives of this inventory are:

- Quantitatively describe distribution patterns of non-native plant species in OLYM, NOCA, MORA, and SAJH.
- Determine which habitats are most susceptible to exotic plant invasion (i.e. where exotic plants are most often found and where populations are most dense).
- Identify which non-native plant species and park habitats should be the highest priorities for control programs.
- Propose methods for long-term monitoring of non-native plant species in park ecosystems.

Methods

General distribution patterns of non-native species will be assessed in long-term vegetation monitoring programs within each park. Currently, a grid-based, probability-sampling strategy, such as that utilized by Forest Inventory Assessment (FIA) Program, is under consideration for use by Network Parks. While this sampling approach will provide a park-wide assessment of the extent and intensity of exotic plant distribution in each park, it will not provide adequate information on areas most susceptible to exotic plant establishment. This survey will focus on these sensitive areas: travel-ways, riparian corridors, and developed zones in Olympic National Park, North Cascades National Park Service Complex, Mount Rainier National Park, and San Juan Island National Historic Park. Fort Clatsop National Memorial already has comprehensive information regarding non-native species. Non-native species will be inventoried at Fort Vancouver National Historic Site during the vascular plant survey described elsewhere in this proposal.

Non-native species generally establish in areas where soils or substrates have been or are being disturbed; in travel-ways where human, stock or vehicular traffic serve as vectors of seeds or plant propagules; and in riparian systems, including wetlands. Sampling will utilize a stratified, random design with strata as listed below:

- Designated or maintained stock trails
- Designated or maintained trails where stock use is prohibited
- Roads - all roads used by motor vehicles
- Developed areas - visitor centers, housing, administrative facilities, trailheads, etc.
- Human caused disturbed areas - areas with a history of human use that are not currently being used and are slated for natural or assisted restoration. Examples include: quarries, logged areas, livestock-grazed areas, stock ponds, farmed areas, golf courses, campgrounds, picnic areas, etc.
- Riparian corridor - riparian corridors of perennial streams will be divided into areas above road intersections, below road intersection, and no roads intersecting the stream from the headwaters until the stream leaves the park boundaries.

All sampling will occur between May and October while plants are still actively growing and plant identification is possible. Sample sites will be inventoried using multi-sized, nested plots. Rectangular (2m x 25m) plots will be use along road and trail corridors due to the linear nature of these habitats. Trees (> 1" d.b.h.) will be sampled within these entire plots and data collected will include species, d.b.h., and height. Shrubs will be documented using line intercept along two transects within the plots. Understory plants will be documented in five 0.5 x 0.5 meter plots systematically located within the 50 square meter plot. Data collected at each site will include species percent cover by class (Daubenmire, 1968), maximum height of shrubs, trees, and forbs, total vegetation percent cover, and general environmental data. Environmental data will include slope, aspect, disturbance regime, elevation, and canopy cover (i.e. from plants not rooted in the plot).

We anticipate dividing these travelway and riparian corridors into segments, similar to the design in the fish sampling protocols, and locating plots within segments. A subset of all trails or roads will be randomly selected for sampling and then a subset of segments will be sampled along the sample trail. In this manner, we will cross elevation and vegetation gradients within one trail and simplify logistics (i.e. rather than sampling along all trails). Plot locations will be documented using Global Positioning System and incorporated into a GIS layer. We will sample a minimum of 30 sites within each of our six strata.

Voucher specimen will be collected for previously unrecorded species in each park or for species occurring in unusual or previously undocumented habitats. Vouchers will include roots, leaves, flowers, and fruit (if possible). Vouchers will be dried in plant presses and mounted on acid free herbarium sheets. Authorities of the taxa or the University of Washington herbarium will verify species that are new to the Pacific Northwest or are difficult to identify. Labels will be prepared including all collection information and specimen will be accessioned into park herbaria.

Data will be stored in an ACCESS or similar database program. Plots will be grouped by vegetation community type for each susceptible area and within areas. Average, minimum and

maximum percent cover of noxious weeds; average species richness; and average total vegetation cover will be determined.

Table 7. Summary of Non-native Plant Species Occurring within each Network Park.

Species	**EBLA**	**FOCL**	**FOVA**	**MORA**	**NOCA**	**OLYM**	**SAJH**
Centaurea diffusa				x	x	x	
Centaurea maculosa				x	x	x	
Chrysanthemum leucanthemum	x	x		x	x	x	
Cirsium arvense	x	x	x	x	x	x	x
Cirsium vulgare	x		x	x	x	x	x
Conium maculatum	x		x				
Cystisus scoparius	x	x	x	x	x	x	x
Digitalis purpurea	x		x	x	x	x	
Geranium robertianum		x		x	x	x	
Hedera helix	x					x	
Heracleum mantegazzianum	x			x		x	
Hieracium atratum				x			
Hieracium aurantiacum		x		x	x	x	
Hypericum perforatum		x	x	x	x	x	x
Hypochaeris radicata		x		x			
Linaria dalmatica ssp. *Dalmatica*					x	x	
Lythrum salicaria		x				x	
Myriophyllum briasiliense		x					
Phalaris arundinacea			x	x	x	x	
Polygonum cuspidatum		x		x	x	x	
Rubus discolor	x				x		
Senecio jacobaea				x		x	x
Tanacetum vulgare	x					x	
Ulex europaeus	x						
Verbascum thapsus	x		x	x	x	x	x

Products

- Maps of plot locations and corresponding known noxious weed locations will be developed in each park's GIS system.
- Quantitative descriptions of noxious weed distributions in the susceptible areas will be included in a final report documenting the methods and results.
- ACCESS database with all vegetation data.
- Recommendations for future monitoring priorities and schedules for determining new infestations and spread of noxious weed populations.
- Voucher specimen.

Schedule

	MORA	NOCA	OLYM	SAJH
2001	x	x		
2002			x	x

FY01 - Initial releve size will be determined and surveys completed at Mount Rainier National Park and North Cascades National Park. Databases will be established and information entered, data analysis and report writing will be initiated.

FY02 - Surveys will be completed at San Juan National Historic Park and Olympic National Park, databases will be updated, data analysis completed, vouchers accessioned into herbaria, and GIS products finalized.

FY03 - Final reports will be completed, monitoring protocol will be established and initiated.

Budget

Coordination and Logistics

The field crew will consist of a GS07 lead biological sciences technician and 2 GS05 biological science technicians. They will be supplemented by 2 GS05 biological science technicians while working at Mount Rainier National Park during FY01. The Exotic Plant Management Team will assist the crew in FY02. The crew will complete all data collection, data entry, and voucher specimen preparation.

The plant ecologist (Kurth) at MORA will: provide project oversight and budget coordination. During FY01 she will supervise the crew based at MORA that will conduct surveys at MORA and NOCA. The Science Advisor at NOCA (Rochefort) will provide logistical assistance while the crew is a NOCA. During FY02, the OLYM-based crew will conduct inventories at OLYM and SAJH and will be under the supervision of the Plant Ecologist at OLYM. Laurie Kurth will assist with training the crew to assure continuity between parks and implementation of sampling methods.

Sampling design and methods will be developed by Laurie Kurth and Dr. Regina Rochefort in the winter (January to March) of 2001. Dr. Ed Schreiner and Dr. Jean-Yves Corbois will review sampling design and data analysis prior to development of databases. Database development will be conducted with the Data Manager at MORA.

Individual field crews will enter data each year. Dr. Regina Rochefort is responsible for data analysis and Rochefort and Kurth will write the final report.

Budget

Cost Category	**Species Inventory Funds**	**LTEM Matching Funds**	**Park Base**	**Other funds**
Personnel:				
Supervisor (Plant Ecologist, GS12)			18,200	
Science Advisor (Plant Ecologist GS13)			11,400	
Biological Sciences Technician GS07	13,200	13,800		
Biological Sciences Technician 2 GS05	18,000	19,000		
Biological Sciences Technician 2 GS05			4,000	
Exotic Plant Management Team (6 people for 3 pps.)				21,600
Travel	5,000	5,000		1,000
Transportation	3,000	3,000		800
Equipment/Supplies	1,000	1,000		
Voucher preparation	1,000	1,000		
Statistical consultation and data management	3,300	3,200		
Total	44,500	46,000	33,600	23,400

Funding by Fiscal Year	**Inventory**	**Monitoring**	**Park Base**	**Other funds**
FY01	25,000	19,500	15,000	
FY02	19,500	25,500	11,000	23,400
FY03			7,600	

Data Management

Introduction

The future value and effectiveness of the Inventory and Monitoring Program relies on effective data management. As evidenced by the goals of the I&M Program, data management for legacy, current, and future data collections is in the forefront of research and natural resource management. The I&M Program's data management goals are reflected in the first two objectives in the North Coast and Cascade's biological inventory study plan, and in the large data management component of the third objective. Accomplishing the study plan's objectives will require an effective and efficient data management system.

Data Management Objectives

To meet the goals of this study plan, our data management objectives are to:

1. Establish a data management committee to develop and support a data management system.
2. Develop and implement a cohesive data management system.
3. Develop relational databases that support the data management system.
4. Create data documentation and dissemination procedures.
5. Continue current data mining and documentation efforts.
6. Produce products in the form of easily accessible databases (spatial and non-spatial), reports, and papers containing scientifically defensible data to support the most informed management decisions possible.

Staff Organization

Effective implementation of a data management system requires the cooperative efforts of staff who will create, use, and store data. To develop, maintain and assist staff in using the system, the North Coast and Cascades Network is hiring three data managers to be stationed at MORA, NOCA, and OLYM. The data managers will work as a team to support the Network's data management needs in addition to the individual parks within the Network. The data managers will be responsible for developing and administering the data management system. They will provide appropriate training for using the database system, and will have authority to accept or reject data for inclusion in the master datasets based on the quality assurance and control criteria detailed in the data management plan. They will promote communication within the Network regarding the systems implementation and integration with other databases. The data managers will be supervised by the Geographic Information Systems (GIS) specialists at the host parks to ensure integration of the I&M data with existing park spatial and non-spatial datasets.

Primary investigators will design research projects and articulate their data collection and management needs to the data managers. Primary investigators, in cooperation with data managers, will design field forms and data collection protocols that support the necessary databases and data management system. Field crews will be responsible for adhering to data collection protocols in the field and for data entry according to established standard operating

procedures (SOP's). Members of the field crew will conduct data verification and initial validation procedures, under the supervision of the primary investigator. The primary investigators will perform further quality assurance and control procedures, and direct data analyses and report generation. Primary investigators are responsible for documenting to the data managers that the data meet the standards established in the data management plan and are ready for inclusion in master datasets.

Geographic Information Systems staff will be involved in developing the Network's data management system so that spatial data management needs are included. Geographic Information Systems staff will provide input and make recommendations during database design and data collection phases to ensure that spatial standards and relationships are met. Spatial data organizational tools, such as the GIS Theme Manager developed by the NRID, will make spatial data more easily accessible to park staff, and GIS staff will provide training in spatial software use. Geographic Information Systems staff will also coordinate the incorporation of GPS data into spatial datasets.

Users of the data that are generated and organized under the data management system will be responsible for supporting the guidelines established for the system. The data managers will provide training to database users about the tools available to them for data use and in the proper use, maintenance, and documentation of data. Users will report any data discrepancies they may find to data managers.

Data Management System

The implementation of a data management system will be a cooperative effort among those who will create, use, and maintain data. The relationships among individual park staff and NCC Network staff are as critical as the relationships within the developed databases. A data management working group has been formed to facilitate communication and data management consistency within the Network. This group, formed during the preparation of the Biological Inventory Study Plan for the Network, will evolve into a data management committee for the Network's inventory and monitoring efforts. The group will oversee database design and ensure data integration at many organizational scales by providing a link among park, NCC Network, and national level data management efforts. The data management committee will develop a data management plan to document data management goals, policies, and maintenance procedures. The data management committee currently consists of the regional I&M coordinator and the GIS specialists (or their representatives) from CCSO, MORA, NOCA and OLYM. With the hiring of data managers in FY01, the Network coordinator(s), the three data managers, a GIS representative, and primary investigators (as appropriate) will participate in this committee.

The data management system will accommodate a variety of biological scales, data formats, and special situations. There are currently many different data formats and databases currently in use, or used in the past. Legacy data will continue to be imported into the most recent data management tools so that is made more accessible. Other data and databases, such as those generated by other agencies will be incorporated into the data management system to maximize information available to park managers, researchers, and the public. Also, each park within the Network will experience unique situations that require database customizations for data storage,

analyses, and reporting. Flexibility will be maintained to incorporate data structural variety into the newly developed data management system, while maintaining standard relationships for linking to Network and national level databases.

Data Organization

A data management plan will be the driver for the data management system. The plan will document how to implement the NCC Network's data management system's goals and policies. The data management committee working with anticipated users of the data management system will identify these goals. The data management plan will cover network-level topics including computer system administration as it relates to data access; the location and type of server that will be used to store master datasets; and procedures for data documentation, maintenance, back-ups, archiving, and dissemination. The plan will also describe "rules" for data collection and evaluation, database design and development, relationship standards, and user interfaces. The plan will also address NCC Network standards for RDBMS and metadata tools where these standards are more specific than those proposed by the NRID.

To allow for anticipated growth in I&M data activities and to meet the current needs of data management and GIS, Network data management activities will be based on a Relational Database Management System (RDMS), such as Microsoft SQL Server. The implementation of a RDMS will also allow for improved Intranet data sharing and potential Internet data portals to promote Network-wide analysis of I&M datasets. The data management committee, with consultation from other RDMS experts, will develop a strategic plan for RDMS implementation as a part of a Network data management plan. This plan will guide the transition to RDMS and ensure seamless integration with existing databases and provide minimal interruption to current park data activities. Access software will be used as the primary tool for viewing, analyzing, and entering data at the park-level since this program is accessible to most park staff, and considerable time has already been spent managing data in Access databases. Access-driven data entry forms and query tools will continue to be used at the desktop level. Existing Access programs such as NPSpecies and Dataset Catalog will continue to serve as the front-end tools for I&M datasets. The Access based applications will link directly to RDMS tables maintained by the data managers. The implementation of RDMS will also provide enhanced capabilities for GIS enabling the use of the new Geodatabase (Environmental Systems Research Institute) data structure. Geographic Information Systems data and non-spatial data will reside together in the RDMS promoting data integration and GIS analysis capabilities.

Data Development

Data development has already begun with the NPSpecies and Dataset Catalog programs. Work on these databases will continue concurrently with development of the Network's data management system. Upcoming survey work (beginning during FY 2001) will require the design and implementation of new databases. Procedures and standards set forth in the data management plan will be followed to create park and Network specific databases.

Data Documentation

Data will be documented using Dataset Catalog in conjunction with commercial metadata software, archived at a designated location, and distributed via established protocols. Dataset Catalog will be used to document all established datasets. It will be used routinely by local park staff to gather general information about datasets. The Dataset Catalog will also be used a means to prioritize which legacy datasets need to have NBII or FGDC compliant metadata completed. The data management committee will work with NRID and other professionals to select a metadata creation software that meets the NBII/FGDC standards and meets Network needs by promoting appropriate data use. Data and its associated metadata that meet NBII or FGDC standards will be made available on clearinghouses and web-sites.

Network I&M data will be backed up automatically on a nightly schedule. Routine copies will be sent either by ftp or CD to the NRID office for archiving.

Data Reporting and Dissemination

Data will be available for distribution through a variety of avenues. The data management plan will provide procedures and guidance for disseminating data from databases (that often contain sensitive information). Other means of data distribution will include annual reports or other documents made available through the Natural Resources Bibliographic reference program (currently NRBib). Spatial data will be included, if appropriate, in the GIS Theme Manager. Additionally, we have already established a prototype website at http://165.83.85.10/northcoastcascades/ (currently available only through the intranet; Figure 9) for sharing plans, reports, maps, metadata and eventually raw data. In the future, we would like to have our Network site available through a link from NRID's I&M page at http://www.nature.nps.gov/im.

The data management system itself, along with the databases and data generated within its protocols and standards, should be treated as one of the products of the I&M initiative. These products will help park managers make informed decisions based on defensible data. Additionally, the data will be highly valuable to future research projects, continued monitoring efforts, and educational programs. Improving our ability to manage natural resources will fulfill Natural Resource Challenge goals and NPS mandates for natural resources protection for the enjoyment of future generations.

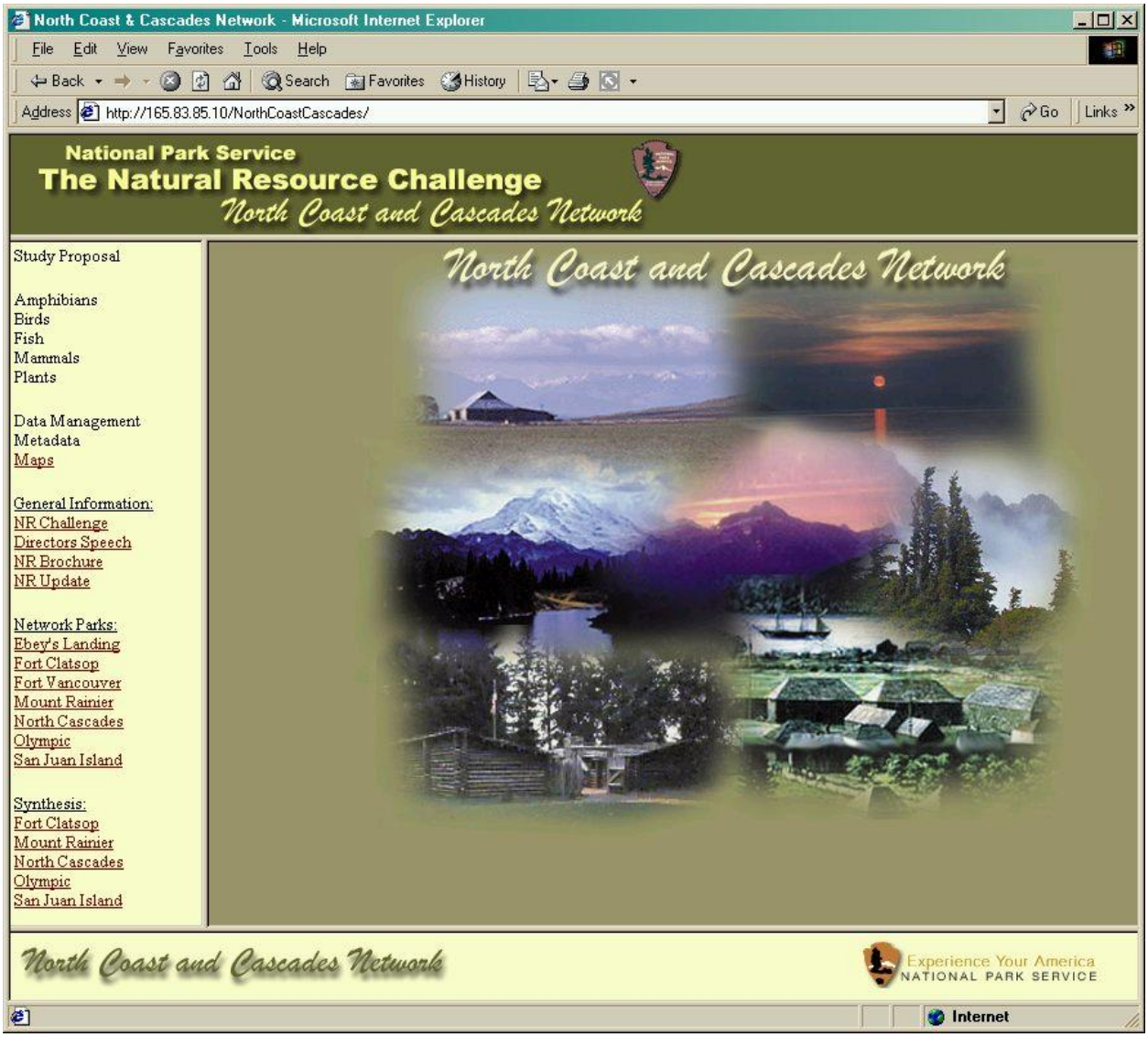


Figure 9. Proposed Web Page for Network Species Inventories.

Products

The following products are anticipated from the NCC Network Inventory:

- Annual and project completion reports for each field survey (i.e. amphibians, landbirds, and marine fish).

- 90% verified species lists for vertebrates and vascular plants in the network.

- Entry of all data into the Data Management Tools developed by the Servicewide I&M Program

- GIS themes and non-spatial databases:
  Geographic Information Systems themes associated with the survey designs will be developed and archived as part of the metadata documenting the surveys. Geographic Information Systems files and other database tables will also be developed from the new field data as well as the historical records. After proper review of QA/QC procedures and standardizing of database structures, these datasets along with associated field records, documents, maps, raw data, photographs etc. will be integrated with the Network data management system.

- Distribution of data and reports on Network web site:
  Plans, reports, maps, metadata and eventually raw data will be provided on a Network I&M web site which will have both intra- and internet access. Initially, the site will be limited to intranet use for the network staff and cooperators. However, we would eventually like to open parts of the site to the public. Ultimately, we would like to include live mapping and data query capabilities using IMS type technologies. This would provide the public with an engaging and easy access interface to the data and results of our inventories, encouraging their support and participation.

- In cooperation with the Resource Education/Interpretation Divisions of all 7 parks in the network, we will develop displays for each park Visitor center. The displays will describe the inventory and monitoring projects underway in the network, and those being conducted specifically in the respective park. Local residents and visitors to the northwest often stop at more than one of the national parks in the area. Through these displays, we will provide consistent messages about the importance of inventory and monitoring, and accomplishments of this program. The displays will reference and complement the website we are developing to provide products from the program (see data management section).

  A poster being designed for the upcoming George Wright Society meeting will be part of the first displays. Ultimately, the visitor center displays will be designed as permanent, dynamic tolls to provide current information about the network and prototype monitoring programs.

  - Data, reports, and information will be shared with the upcoming NCC Learning Center

Budget

The four-year budget for the North Coast and Cascades Network is $692,636. General budget overview and tracking will be the responsibility of the Science Advisor at North Cascades (Regina Rochefort). Program leads will manage budget for their specific project. For example, Barbara Samora will manage the Amphibian budget for all field crews based at MORA while Reed Glesne will manage the funds for crews based at NOCA. The Landbird project will probably be contracted out so Bob Kuntz will serve as the budget manager for all parks although Patti Happe and Jim Petterson will be the local contact for the logistics contractor when work is conducted in their park. All administrative funds (travel, data managers, supplies) will be managed at NOCA by Regina Rochefort.

Annual budget requests are summarized in Table 8 and Table 9 summarizes distribution by task and priority.

Table 8. Annual Budget Request for North Coast and Cascades Network.

Task	FY2001	FY2002	FY2003	FY2004	Cost
Document at 90% Verification Level		**Priority 1**			
Method - Searches of Literature & Collections	$28,300				$28,300
Travel by Core Committee	$5,000				$5,096
Supplies and Materials to Support Report Production	$2,000			$2,336	$4,336
Method – Field Surveys					
Birds		$13,400	$6,700	$6,700	$26,800
Amphibians		$44,400			$44,400
Fish	$34,300	$7,900			$42,200
Vascular Plants – surveys of under-surveyed areas and listed species	$32,500	$43,800	$5,000	$27,100	$108,400
Collect Existing Spatial Data		**Priority 2**			
Assemble existing data , enter into NPSpecies and link data with park GIS		$61,600			$61,600
Distribution and Relative Abundance Surveys		**Priority 3**			
Birds	$20,000	$30,000	$33,334	$16,666	$100,000
Forest Carnivores	$16,000	$25,000	$25,000	$12,500	$78,500
Amphibians & Reptiles		$17,600	$20,200		$37,800
Fish		$55,400	$55,400		$110,800
Exotic Plant Abundance and Distribution	$25,000	$19,500			$ 44,500
Total Inventory Request	$163,100	$318,600	$145,634	$65,304	$692,636

Table 9. Budget Itemization by Network Park and Inventory Task.

Task	EBLA	FOCL	FOVA	MORA	NOCA	OLYM	SAJH	Total Cost
Document at 90% Verification Level	**Priority 1**							
Method - Searches of Literature & Collections	$2,180	$2,180	$2,180	$6,540	$6,500	$7,280	$1,090	$28,340
Travel by Core Committee	$5,000							$5,000
Supplies and Materials to Support Report Production	$4,336							$4,336
Method – Field Surveys								
Birds	$6,700	$6,700	$6,700				$6,700	$26,800
Mammals	Included with distribution studies in Priority 3							
Amphibians & Reptiles	$13,260	$12,260	$8,440				$10,440	$44,400
Fish		$11,000 (with MORA)		See FOCL		$31,200		$42,200
Vascular Plants	$5,000		$4,000		$19,000	$17,000	$19,000	$64,000
Listed Plant Species				$15,300	$19,000	$10,100		$44,400
Collect Existing Spatial Data	**Priority 2**							
Assemble existing data , enter into NPSpecies and link data with park GIS	$2,180	$2,180	$2,180	$14,170	$14,170	$16,270	$5,450	$56,600 $5,000-SO
Distribution and Relative Abundance Surveys	**Priority 3**							
Birds				$33,333	$33,334	$33,333		$100,000
Forest Carnivores	Budget reflects financial management responsibility, each crew will survey 2-3 parks			$27,462	$23,962	$23,962		$78,500
Amphibians & Reptiles				$17,600	$20,000			$37,600
Fish				$110,800				$110,800
Exotic Plant Abundance and Distribution				$25,000		$19,500		$44,500
Total Cost								$692,636

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Appendix 1. Contact information for members of steering committee

Name	Area Representing	Telephone	E-mail Address	Mailing Address
Dr. Regina Rochefort	Steering Committee Coordinator; Science Advisor	(360)856-5700 x 254	regina_rochefort@nps.gov	North Cascades N P Service Complex 2105 State Route 20 Sedro-Woolley, WA 98284
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Cat Hawkins Hoffman	Olympic National Park	(360)452-0314	cat_hoffman@nps.gov	Olympic National Park 600 East Park Avenue Port Angeles, WA 98362
Cicely Muldoon	San Juan Island National Historical Park	(360) 378-2240	cicely_muldoon@nps.gov	San Juan Island NHP P.O. Box 429 Friday Harbor, WA 98250

Appendix 2. Contact information for members of core committee.

Name	Area Representing	Telephone	E-mail Address	Mailing Address
Dr. Regina Rochefort	Steering Committee Coordinator; Science Advisor	(360)856-5700 x 254	regina_rochefort@nps.gov	North Cascades N P Service Complex 2105 State Route 20 Sedro-Woolley, WA 98284
Leigh Smith	Ebey's Landing National Historical Reserve	(360) 873-4590 x 31	leigh_smith@nps.gov	North Cascades National Park 7280 Ranger Station Road Marblemount, WA 98267
Scott Stonum	Fort Clatsop National Memorial	(503)861-2471 x 228	scott_stonum@nps.gov	Fort Clatsop N M Route 3, Box 604-FC Astoria, OR 97103
Gregg Fauth	Fort Vancouver National Historic Site	(360) 696-7659 x 14	gregg_fauth@nps.gov	Fort Vancouver NHS 612 East Reserve Street Vancouver, WA 98661
Jim Petterson	Mount Rainier National Park	(360) 569-2211 x 3373	jim_petterson@nps.gov	Mount Rainier National Park Tahoma Woods, Star Route Ashford,WA 98304
Barbara Samora	Mount Rainier National Park	(360) 569-2211 x 3372	barbara_samora@nps.gov	Mount Rainier National Park Tahoma Woods, Star Route Ashford,WA 98304
Laurie Kurth	Mount Rainier National Park	(360) 569-2211 x 3374	laurie_kurth@nps.gov	Mount Rainier National Park Tahoma Woods, Star Route Ashford,WA 98304
Reed Glesne	North Cascades National Park Service Complex	(360)856-5700 x 369	reed_glesne@nps.gov	North Cascades N P Service Complex 2105 State Route 20 Sedro-Woolley, WA 98284
Bob Kuntz	North Cascades National Park Service Complex	(360) 856-5700 x 368	robert_kuntz@nps.gov	North Cascades N P Service Complex 2105 State Route 20 Sedro-Woolley, WA 98284
Dr. Patti Happe	Olympic National Park	(360) 452-4501 x 240	patti_happe@nps.gov	Olympic National Park 600 East Park Avenue Port Angeles, WA 98362
John Meyer	Olympic National Park	(360) 452-4501 x 246	john_meyer@nps.gov	Olympic National Park 600 East Park Avenue Port Angeles, WA 98362

Appendix 2. Contact information for members of core committee (continued).

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Dr. Steve Fradkin	Olympic National Park	(360)374-1222	steve_fradkin@nps.gov	Olympic National Park 600 East Park Avenue Port Angeles, WA 98362
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Appendix 3. Collaborators for planning and designing biological inventories.

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Shelley Spalding
US Fish and Wildlife Service
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Appendix 4. Collections contacted for specimens from National Parks.

Burke Museum of Natural History & Culture
P. O. Box 353010, University of Washington Campus
Seattle, WA 98195-3010 206/543-7907 Dr. Karl Hutterer, Director

James R. Slater Museum of Natural History
University of Puget Sound
Tacoma, WA 98416 253/879-3798 Dr. Dennis Paulson, Director
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Biology Department
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Dr. David Morgan
Western Washington University
Department of Biology
Bellingham, Washington

Skip Pass
Skagit Valley College
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Washington Natural Heritage Program
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PO Box 4700
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Steve Farone, Information Manager

State of Washington
Department of Fish and Wildlife, Habitat Program
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Appendix 5. Curriculum Vita of Program leads and Collaborators.

Brendan Joseph Brokes
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Education

1987 – B.A., Biology; Botany minor ,Humboldt State University, Arcata, CA

1999 – M.S., Fisheries Science, Oregon State University, Corvallis, OR.

Professional Experience

1997-present - Biological Technician (Aquatic Ecology), Mount Rainier National Park (MORA), Ashford, WA.

Serve as field supervisor for four-year park-wide amphibian inventory of lentic and lotic systems. Supervise, train, and organize logistics for lakes, streams, and wetland field crews (11-16 persons, includes GS-5, GS-6, and GS-7 employees).

June – September 1996 -Visiting Researcher (N.B.S. Aquatic Ecologist), MORA

- Gathered data for MS thesis research and park databases. Additionally charged with training, and organizing the six person amphibian and wetland field crews.
- Responsible for ground-truthing NWI (National Wetlands Inventory) maps, and reclassifying or modifying if necessary.
- Summarized and analyzed data for MS thesis. Knowledge of, and experience in multivariate statistical analysis and software packages (NCSS, SYSTAT, SAS, Excel and Sigmaplot).

1991-1995 - Biological Technician (Aquatic Ecology and Wildlife), MORA, seasonally:

Organized and participated in a baseline data study designed to inventory and document the herpetological taxa in terrestrial and aquatic environments throughout MORA. Received extensive training in species identification and survey techniques from local amphibian and reptile experts. Established and monitored long-term aquatic study sites to examine species diversity and reproductive success of amphibians and reptiles found in the park. Gillnetted lakes and ponds to determine fish species composition and relative abundance. Supervised and trained new personnel in sampling techniques and protocols (water chemistry collection and amphibian surveys), laboratory procedures, and GPS mapping.

June –October 1989 - High Seas Gillnet Fisheries Observer, National Marine Fisheries Service, Seattle, WA.

- Pioneer program designed to document the impact of gillnetting (driftnet) on the pelagic ocean ecosystem. Observed and recorded incidental catch of marine mammals, seabirds, sea turtles, and other by-catch on a Japanese squid gillnet vessel in the central North Pacific.

- Performed marine mammal transects and necropsies. Necropsy samples included teeth, liver tissue, fluke muscle tissue, stomach contents, and intestinal tissue. Cooperated and collaborated with Japanese observer, crew, and officers.
- Data recorded included species, sex, location, water temperature, time of day, associated organisms, vessel information, net type and size, mesh type and size, set, soak, and retrieval times. Also monitored the dumping of hazardous materials, and course and heading.

November 1988 – May 1989: Industrial Hygienist, Esstek, Seattle, WA.

- Monitored, sampled, and analyzed air quality during asbestos abatement projects. Responsible for analyzing airspace samples and ensuring compliance with state and federal regulations which included monitoring workers' personal airspace, as well as containment airspace.
- Worked and cooperated closely with state and federal air quality officials and private industry to ensure air quality regulation compliance and "smooth" job-site relations.

June - September 1987 and May - July 1988 -Foreign Fisheries Observer, National Marine Fisheries Service, Seattle, WA.

- Functioned as a federal fisheries "agent" observing the catch on foreign vessels in U.S. waters in accordance with the Magnuson Act. Two tours in the Bering Sea and Aleutian Islands. Duties included documenting the vessel's compliance with federal regulations, sampling catch, monitoring catch of prohibited species, and recording other biological data. Cooperated and collaborated with Korean crew and officers.
- First tour was preceded by an extensive training session in fish biology, species identification, sampling techniques, compliance regulations, and safety procedures.

Publications

Brokes, Brendan. 1999. Habitat Segregation of Two Ambystomatids in Mountain Ponds, Mount Rainier National Park. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Samora, B.A., B.J. Brokes, C.D. McIntire, and G.L. Larson. In prep A. Inventory of Amphibians in Aquatic Habitats of Mount Rainier National Park, 1996-1999. Mount Rainier National Park. Ashford, Washington.

Samora, B.A., J. Feola, and B. Brokes. 2000. Survey of Salmonid Species in Streams of Mount Rainier National Park, 1999.

Biographical Sketch: Jean-Yves Pip Courbois

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Professional Preparation:

University of North Carolina at Chapel Hill NC.	Biology/Ecology	B.S. 1989
Oregon State University, Corvallis OR.	Statistics	Ph.D. 2000
University of Washington, Seattle WA.	Statistics	2000 - present

Appointments:

Research Associate, Statistics Department and The National Research Center for Statistics and the Environment. University of Washington, Seattle, WA. January 2000-present.

NNEMS student fellowship recipient. US Environmental Protection Agency, Corvallis Research Laboratory, ORD Western Ecology Division, Corvallis OR. May 1995 through August 1999.

Most Relevant Publications:

Courbois, J. P. 2000. Tools for Environmental Statistics; Creative Visualization and Variance Estimation Under Complex Designs. Ph.D. Thesis, Oregon State University.

Carr, D. B., Olsen A. R., Pierson S. M., and Courbois J. P. 2000. Using Linked Micromap Plots to Characterize Omernik Ecoregions. Knowledge Discovery and Data Mining Journal, 4(1): 43-67.

Courbois, J. P. 1999. A Direct Search Method for Projection Pursuit Guided Tours. Invited topic session presentation given at The Joint Statistical Meetings, August 1999. Also presented at The Oregon State University Graduate Student Conference, April 7, 1999.

Carr, D. B., Olsen A. R., Pierson S. M., and Courbois J. P. 1999. Box Plot Variations in a Spatial Context: An Omernik Ecoregion Weather Example. Statistical Computing and Graphics Newsletter, 9(2), Winter 98/99.

Synergistic Activities

Vice President Oregon State University Graduate Student Association, 1998-99. My participation in the GSA included successfully acquiring a $141,000 grant to create The Graduate Student Multimedia Presentation Center. The center supplies graduate students with the material and support they need to create modern presentations. We were also awarded the student organization of the year award.

Memberships

American Statistical Association
The International Environmetrics Society
The National Peace Corps Association

Collaborators and Other Affiliations

(i) Collaborators

Dr Dan Carr (Statistics, George Mason University), Dr Tony Olsen (US-EPA, Corvallis, OR), Dr Paul Sampson (Statistics, University of Washington), Dr Scott Urquhart (Statistics, Oregon State University).

(ii) Graduate and Postdoctoral Advisors

Dr Jeffery Arthur, Dr Cliff Pereira, Dr Fred Ramsey, Dr Scott Urquhart (all at Oregon State University)

(iii) Thesis Advisor and Postgraduate-Scholar Sponsor

None yet.

Steven C. Fradkin, Coastal Ecologist

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Academic and Professional Experience:
B.S. (Zoology), Michigan State University, 1989
M.S. (Aquatic Ecology), Michigan State University, 1992.
Ph.D. (Aquatic Ecology), Dartmouth College, 1997
Post-doctorate Research Associate (Marine Ecology), University of Oregon, Oregon Institute of Marine Biology, 1997-1998.
Ecologist: 1999-2000. CH2M HILL, Portland, Oregon.
Coastal Ecologist: 2000-Present. Olympic National Park

Professional Organizations and Activities:
American Microscopical Society (reviewer for *Invertebrate Biology*)
American Society of Limnology and Oceanography (reviewer for *Limnology and Oceanography*)
Ecological Society of America (reviewer for *Ecology*)
National Science Foundation: Reviewer for Population Biology Panel

List of publications:
Fradkin, S. C., and J. J. Gilbert. 1996. Daphnia vertical distribution and the presence of toxic cyanobacteria. Hydrobiologia.339:7-12
Fradkin, S. C. 1995. Effects of interference and exploitative competition from large-bodied cladocerans on rotifer community structure. Hydrobiologia. 313:387-393.
Fradkin, S. C. in press. The distribution of marine rotifers across the northeastern pacific continental shelf. Hydrobiologia.
Fradkin, S. C. in revision. Effects of environmental variation on zooplankton population dynamics Freshwater Biology
Fradkin, S. C. in review. Phylum Rotifera. In: R. I. Smith and J. T. Carlton (eds.), Light's Manual: Intertidal invertebrates of the central California coast. 4th Edition.
Fradkin, S. C. in prep. Costs of asexual diapause polymorphism in a planktonic rotifer population. (to be submitted to Ecology)

Invited Seminars
Smithsonian Environmental Research Center, 2000; Max Plank Institute for Limnology (Germany), 1998; University of Konstanz (Germany), 1998; California State University, Sacramento, 1998; The Institute of Ecosystem Studies, Milbrook NY, 1996
IX International Rotifer Symposium, Khon Kaen, Thailand, 2000

Curriculum Vitae

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Education

1993	Ph.D. Rangeland Resources. Oregon State University, Corvallis, OR.
1983	M.S. Wildlife Ecology. . Oregon State University, Corvallis, OR.
1978.	B.S. Environmental Resource Management. Pennsylvania State University, State College, PA.

Professional Experience

1996- present	Supervisory Wildlife Biologist, Olympic National Park.
1995-1996	Wildlife Biologist, Wrangell-St. Elias National Park and Preserve. Responsibilities included monitoring a variety of wildlife species, including caribou, moose, snowshoe hair, and breeding birds.
1993-1995	Environmental Specialist, Wrangell-St. Elias National Park and Preserve. Responsibilities: NEPA, CERCLA, RCRA and other compliance. Monitored impacts of ongoing and abandoned mines; issues included water quality and revegetation. Designed and implemented research on impacts of ATV use on sub-arctic tundra, tested mitigation techniques, and set up long-term impacts monitoring.
1987-1990	Research Assistant/ Ph. D Candidate. Cooperative Park Studies Unit, Oregon State University, Corvallis, OR. Responsibilities: Designed, conducted, and analyzed research on ungulate- forage relationships in Olympic National Park. Duties included supervising an analytical lab at OSU.
1983-1985	Research Assistant, Dairy Nutrition, University of Idaho. Supervised implementation of research on dairy cattle nutrition. Responsibilities included running 2 analytical labs, supervising graduate students in their research, and conducting trails with cattle at the university dairy.
1982-1983	Field Assistant, Wildlife Ecology, University of Idaho. Assisted with research on ungulate-habitat relationships in Glacier National Park, MT.

1978-1981 Graduate Student and Teaching Assistant, Oregon State University. Researched effects of suburban development on black-tailed deer, and assisted in mammalogy, wildlife techniques, and big game management classes.

Selected Publications

Happe, P.J. 1999. Restoring the Gray Wolf to Olympic National Park: Background Information & Current Status. Proceedings of the 1998 Meetings of the George Wright Society.

Happe, P.J., and K. E. Shea, and W,M, Loya. 1998. Assessment of all-terrain vehicle (ATV) impacts within Wrangell-St. Elias National Park and Preserve, Alaska. 1997 Wrangell-St. Elias National Park and Preserve Research and Resource Management Report. No. 97-2.

K. E. Shea, P.J. Happe, and W. M. Loya. 1998. Mitigation of all-terrain vehicle (ATV) using natural and geosynthetic materials for surface hardening in Wrangell-St. Elias National Park and Preserve, Alaska. WRST Research and Resource Management Report No. 97-3.

Schreiner, E.G., K.A. Krueger, P.J. Happe, and D.B. Houston. 1996. Understory patch dynamics and ungulate herbivory in old-growth forests of Olympic National Park, WA. Can. J. For. Res. 26:255-265.

Happe, P.J. 1993. Ecological relationships between cervid herbivory and understory vegetation in old-growth Sitka spruce-western hemlock forests in western Washington. PhD Theses, Oregon State University, Corvallis, OR. 147 pp.

Jenkins, K. J., P. J. Happe, and R. G. Wright. 1990. Evaluating above-snow browse availability using non-linear regression. Wildl. Soc. Bull. 17:55-61.

Happe, P. J., K. J. Jenkins, E. E. Starkey, and S. H. Sharrow. 1990. Nutritional quality and tannin astringency of browse in clear-cuttings and old-growth forests. J. Wildl. Manage. 54:557-566.

Hein, M., E. Grings, R. Roffler, and P. Happe. 1990. Evaluation of a pellet formulated to replace whole cottonseed in the diet of dairy cows in early lactation. J. Dairy Sci.

Happe, P.J. 1983. Effects of suburban residential developments on Columbian black-tailed deer. MS Thesis, Oregon State University, Corvallis, OR.

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Research Interests:

Design of long-term ecological monitoring in National Parks, Population and community ecology of large mammals, Wildlife community-forest habitat relationships, Population estimation and modeling.

Education:

Ph.D. 1985	University of Idaho, Moscow, Wildlife Resources (Major), Forest Resources (Minor)
M.S. 1980	Oregon State University, Corvallis, Wildlife Ecology (Major), Rangeland Resources (Minor)
B.S. 1977	University of California, Davis, Zoology

Professional Experience:

1996 - Present	Research Wildlife Biologist, GS-486-13, U.S.G.S. Biological Resource Division, Forest and Range Ecosystem Science Center, Olympic Field Station.
1991 - 1996	Station Leader and Research Wildlife Biologist, GS-486-12, National Biological Service (formerly National Park Service), Alaska Science Center, Wrangell-St. Elias National Park/Preserve Field Station.
1987 - 1991	Assistant Professor, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings.
1985 - 1987	Post-doctoral Research Associate, Oregon Cooperative Park Studies Unit, College of Forestry, Oregon State University, Corvallis.
1980 - 1981	Research Associate, Oregon Cooperative Park Studies Unit, College of Forestry, Oregon State University, Corvallis.

Academic Affiliation:

Affiliate Assistant Professor, Department of Biology and Wildlife, University of Alaska, Fairbanks. 1992-Present.

Professional Societies and Service:

The Wildlife Society, Associate Editor, Journal of Wildlife Management, 1993-95.
American Society of Mammalogists
Society for Conservation Biology

Selected Publications:

Barten, N. L., R. T. Bowyer and K. J. Jenkins. n Press. Habitat use by female caribou: tradeoffs associated with parturition. Journal of Wildlife Management.

Woodward, A. K. J. Jenkins and E. G. Schreiner. 1999. The role of ecological theory in long-term ecological monitoring: report on a workshop. Natural Areas Journal 19:223-233.

Jenkins, K. J. and E. E. Starkey. 1996. Simulating secondary succession of elk forage values in a managed forest landscape, western Washington. Environ. Manage. 20:715-724.

Jenkins, K. J. and E. E. Starkey. 1993. Winter forage and diets of elk in old-growth and regenerating forests in the western Cascade Range, Washington. Am. Midl. Nat. 130:299-313.

Schroer, G. L., K. Jenkins and B. B. Moorhead. 1993. Roosevelt elk selection temperate rain forest seral stages in western Washington. Northwest Science 67:23-29.

Happe, P. J., K. J. Jenkins, E. E. Starkey, and S. H. Sharrow. 1990. Nutritional quality and tannin astringency of browse in clear-cuttings and old-growth forests. J. Wildl. Manage. 54:557-566.

Jenkins, K. J., and R. G. Wright. 1988. Resource partitioning and competition among cervids in the northern Rocky Mountains. J. Appl. Ecol. 25:11-14.

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Education

1986 M.S. Biology, University of Chicago, Chicago, Illinois.

1984 B..S. Botany, Ohio University, Athens, Ohio.

Professional Experience

1999 - present Botanist, Mount Rainier National Park. Responsibilities: vegetation and soil restoration, rare plant monitoring, exotic plant inventories and control, human impacts surveys in wilderness areas, greenhouse propagation of native plants, long-term plant monitoring program, and assessment of impacts to plant communities from park activities

1995 - 1999 Botanist, Zion National Park. Responsibilities: initiate the park's first plant ecology program, desert restoration, initiate greenhouse propagation of native plants, visitor impacts surveys and mitigation, exotic plant inventories and control, fire effects on rare plants, long-term vegetation monitoring, and assessment of impacts to plant communities from park activities

1988 - 1995 Plant Ecologist, Glacier National Park. Responsibilities: develop fire effects monitoring program, fire ecology assessments, develop and implement restoration effectiveness monitoring program, rare plant surveys, and assessment of impacts to plant communities from park activities

1987 - 1988 Botanist, Corps of Engineers, Chicago, Illinois. Responsibilities: wetland determinations and evaluate proposals for construction activities in waterways and wetlands.

Publications

Kurth, Laurie L. and Nathan C. Benson. 1995. Prescribed fire in two prairies in the north fork of the Flathead River Valley of Glacier National Park. In: Proceedings: symposium on fire in wilderness and park management; 1993 March 30 - April 1; Missoula, MT. Gen. Tech. Rep. INT-GTR-320. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 283 p.

Benson, Nathan C. and Laurie L. Kurth. 1995. Vegetation establishment on rehabilitated bulldozer lines after the 1988 Red Bench Fire in Glacier National Park. In: Brown, James K., Robert W. Mutch, Charles W. Spoon, Ronald H. Wakimoto, tech. coords. Proceedings: symposium on fire in wilderness and park management; 1993 March 30 - April 1; Missoula,

MT. Gen. Tech. Rep. INT-GTR-320. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 283 p.

Kurth, Laurie L. 1996. Examples of fire restoration in Glacier National Park. In: Hardy, Colin C. and Stephen F. Arno, eds. The use of fire in forest restoration. Gen. Tech. Rep. INT-GTR-341. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 86 p.

Lange, David and Laurie L. Kurth. 1991. Exotic vegetation management plan, Glacier National Park. Unpublished report. U.S. Department of Interior, Glacier National Park, West Glacier, MT.

Kurth, Laurie. 1988. Investigations into methods for the control and eradication of leafy spurge in Big Prairie, Glacier National Park. Unpublished report. U.S. Department of Interior, Glacier National Park, West Glacier, MT.

Shearer, Raymond C., Rachel W. Potter, Laurie L. Kurth, Jennifer M. Asebrook. 1996. Cooperation enhances revegetation efforts in Glacier National Park. Park Science 16(1): 20-21.

Zimmerman, Tom, Fred Vanhorn, Laurie Kurth, Thad Stewart. 1995. Prescribed natural fire management: lessons learned in the Glacier National Park Classroom. Park Science 15(3): 20-22.

Curricula Vitae:

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Born: December 14, 1950, Tulsa, OK.

Education:

B.S. 1979. Biology. Eastern Washington University, Cheney, WA.

Professional Appointments:

1998 -	Terrestrial Wildlife Workgroup Leader, National Park Service, Sedro Woolley, WA.
1987-1998:	Wildlife Biologist, National Park Service, Sedro Woolley, WA.
1987:	Wildlife Biologist, U.S. Fish & Wildlife Service, University of Maine, Orono, ME.
1986:	Biological Technician, U.S. Fish & Wildlife Service, King Salmon, AK.
1985:	Biological Technician, U.S. Forest Service, Forestry Sciences Lab., Olympia, WA.
1984:	Biological Technician, U.S. Fish & Wildlife Service, King Salmon, AK.
1983:	Wildlife Biologist, Bureau of Land Management, Glennallen, AK.
1980-1982:	Biological Technician, Bureau of Land Management, Boise, ID.

Professional Services:

Washington Ornithological Society, Board of Directors and Membership Chair, 1998 -
The Wildlife Society, Washington Chapter, North Puget Sound Region Representative, 1995-1996.

Professional Societies:

Cooper's Ornithological Society, 1986 -
Washington Ornithological Society, 1988 -
The Wildlife Society, 1994 -

Publications:

Dunwiddie, P.W. and R.C. Kuntz II. In press. Long-term trends of bald eagles in winter on the Skagit River, Washington. Journal of Wildlife Management.

Carey, A.B., V.E. Castellano, C. Chappell, R. Kuntz, R.W. Lundquist, B.G. Marcot, S.K. Nelson, P. Sullivan, tech. Comp. 1990. Training guide for bird identification in Pacific Northwest Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-260. Portland, OR:USDA, Forest Service, Pacific Northwest Research Station. 28 pp.

Marks, J.S., R.C. Kuntz II, and A.G. Larson. 1982. Photographic record of the red knot in Idaho. The Murrelet 63(2): 72.

John Meyer, Fishery Biologist

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Olympic National Park
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Academic Training:

B.S., General Biology Seattle Pacific University, 1972
B.S., Fisheries, University of Washington, 1974

Professional Experience:

1973-1986: Fishery Biologist, U.S. Fish and Wildlife Service, Olympia, Washington.

1986-Present: Fishery Biologist, Olympic National Park, Port Angeles, Washington.

Professional Organizations:

American Fisheries Society

List of Reports Authored or Co-authored:

Meyer, J. 1977. Report to the Regional Task Force of the Presidential Task Force on Northwest Fisheries Problems concerning steelhead. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 44.

Waknitz, W., C. Mahnken, and J. Meyer. 1977. Report to the Regional Task Force of the Presidential Task Force on Northwest Fisheries Problems concerning salmon and steelhead production (hatchery and wild) from Boldt Case area river basins from 1952-1976. p. 51.

Meyer, J., and D. Vogel. 1978. An examination of the smaller benthic invertebrates in Hylebose Waterway, Tacoma, Washington. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 11.

Meyer, J., and R. Adair. 1978. Puget Sound herring surveys, including observations of the Gulf of Georgia sac-roe fishery, 1975-1977. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 96.

Meyer, J. 1979. A review of the literature on the value of estuarine and shoreline areas to juvenile salmonids in Puget Sound, Washington. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 24.

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Meyer, J., J. Hiss, and R. Boomer. 1983. An application and assessment of a steelhead habitat model. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 33.

Rensel, J., K. Fresh, J. Ames, R. Emmett, J. Meyer, T. Scribner, S. Schroder, and C. Willis. 1984. Evaluation of potential species interaction effects in the planning and selection of salmonid enhancement projects. Species Interaction Work Group of the Salmon and Steelhead Conservation and Enhancement Act of 1980. p. 80.

Meyer, J., J. Blum, S. Dilley, and R. Boomer. 1985. Distribution and abundance of juvenile salmonids in Clallam Bay and Neah Bay, Washington. Prepared for the US ACOE, Seattle District, Washington by USFWS, Fisheries Assistance Office, Olympia, Wash. and Makah Tribal Council. p. 37.

Hiss, J., J. Meyer, and R. Boomer. 1986. Hatchery winter steelhead contribution to the Hoh River fisheries and potential impacts on the native stock. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 62.

Wunderlich, R., D. Zajac, and J. Meyer. 1988. Evaluation of steelhead smolt survival through the Elwha Dams. USFWS, Fisheries Assistance Office, Olympia, Wash. p. 31.

Meyer, J. 1990. Assessment of artificial barriers to anadromous fish in Olympic National Park. Olympic National Park, p. 25.

Department of the Interior. 1994. The Elwha report, restoration of the Elwha River ecosystem and native anadromous fisheries. p. 174.

Olson, R., and J. Meyer. 1994. Survey of non-native fish in selected interior lakes of Olympic National Park, 1992-1994. Olympic National Park, Natural Resources Management Division, p. 67.

Wunderlich, B., B. Winter, and J. Meyer. 1994. Restoration of the Elwha River ecosystem. Fisheries, Vol. 19, No. 8, pp. 11-19.

Adams, C., R. Reisenbichler, and J. Meyer. 1996. Elwha River ecosystem restoration studies – Life history and habitat utilization of resident fish species in the Elwha River. Progress Report to Olympic National Park, p. 23.

Jacobs, R., G. Larson, J. Meyer, N. Currence, J. Hinton, M. Adkison, R. Burgner, H. Geiger, and L. Lestelle. 1996. The sockeye salmon population in Lake Ozette, Washington. NPS, Tech. Report NPS/CCSOSU/NRTR-96/04. p. 140.

Brenkman, S., and J. Meyer. 1999. Distribution and spawning migration of bull trout in the Hoh River Basin, Washington. Olympic National Park, Natural Resources Management Division, p. 45.

Meyer, J., and S. Brenkman. Draft. Water quality conditions in the Lake Ozette Basin, Washington and potential impacts to salmonids. Olympic National Park, Natural Resources Management Division.

Jim R. Petterson, Jr.

Biographical

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Education

M.S. Wildlife Ecology, University of California - Davis, 1988. GPA: 3.9 Emphases on Vertebrate Ecology & Physiological Ecology

Secondary School and Community College Teaching Credentials, University of California - Davis, 1989. Zoology, Ecology, & General Biology.

B.S. Electronics Engineering, North Dakota State University, 1981. GPA: 3.3

Work Experience

Wildlife Ecologist, Mount Rainier National Park, WA (July, 1999 to Present). Designed field projects, developed study proposals, and obtained funding for conducting inventories of bats, Canada lynx, and marbled murrelets. Also continued long-term population monitoring efforts for northern spotted owls and elk. Developed educational materials, presented informational talks, and implemented wildlife management actions relating to conflicts between visitors, mountain lions, and black bears. Developed ACCESS 2000 databases to archive and store owl, murrelet, bat, and Canada lynx field data.

Ecologist, Organ Pipe Cactus National Monument, AZ (February 1997 to July, 1999). Served as coordinator for the Long-term Ecological Monitoring Program. Directed, planned, and performed field work; analyzed and reported on data associated with the following program elements: animal monitoring (birds, lizards, nocturnal rodents, bats, desert pupfish), plant monitoring (vegetation communities, ephemeral (annual) plants, T/E species, various cactus), air and water quality, and weather stations.

Wildlife Biologist, Grand Canyon National Park, AZ. (January 1995 - February 1997). Wildlife specialist responsible for the design, development, implementation, and documentation of the park's wildlife management and monitoring program. Served as principle investigator on several avian monitoring and bat projects. Acted as the T&E Coordinator for associated field projects, interagency planning and recovery meetings, and public meetings. Deployed capture drugs used for anesthetizing ungulates needing relocation. Wrote individual SOP's for mountain lion management, and the overall Wildlife Monitoring and Management section of the Resource Management Plan.

Natural Resource Management Specialist, Virgin Islands National Park, St. John, VI. (May 1992 - January 1995). Responsible for implementing wildlife management projects relating to: monitoring shorebirds, waterfowl, seabirds, warblers, sea turtles, and bats; mongoose control; donkey immunocontraception, and wild pig reduction. I also graduated from the NPS Natural Resource Management Training Program, which involved receiving 25 weeks of courses and workshops in a wide variety of topics and discipline (see list of training courses).

Chief of Resource Management, Division of Science and Resource Management, Northwest Alaska Areas, Kotzebue, AK. (August 1990 - May 1992). Responsible for implementing a varied natural resource management program involving studies of shorebirds, waterfowl, passerines, raptors, grizzly bears, wolves, caribou, and salmon.

Wildlife Biologist, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, (May 1990 - August 1990). Served as project leader for a migratory bird project conducted on northern Alaskan coast that compared bird habitat use and prey selection at two study sites.

Wildlife Ecologist, QUAD Consultants, Sacramento, CA (October 1989 - March 1990). Designed and executed environmental impact studies to determine the potential effects of development projects on critical habitats and sensitive populations of Federally and State listed animal species. Authored biological assessments and environmental impact reports.

Biological Technician, King's Canyon/Sequoia National Park (May - September 1988; June - August 1989). Conducted field inventories for terrestrial vertebrates. Responsible for sampling design, field collection and identification of animals, and preparation of museum specimens.

Research Assistant, Yosemite National Park, (June - August 1987).
Conducted independent project that investigated relative abundances of mammalian prey used by great grey owls. Assisted in trapping, radiotracking, and making behavioral observations of great grey owls.

Electronics Engineer, IBM Corporation and National Semiconductor Corporation, Santa Clara, CA. (July 1981- August 1986). Designed electronic integrated circuits and telecommunications computers, wrote software for controlling circuitry, and gave technical presentations.

Teaching Experience

Graduate Research Assistant, University of California - Davis. (September 1989 - March 1990). Developed a new teaching curriculum for the mammalogy laboratory I had taught twice previously. Wrote a new 130 page manual that stressed the relationships between habitat parameters and wildlife use and developed a 250 slide audio-visual presentation with accompanying script.

Lecturer, American River Community College - Sacramento (September 1989 - January 1990). Instructed a 4 unit upper division course in general biology. Responsible for independent preparation of all materials for lectures, handouts, laboratories, and tests.

Lecturer, University of California - Davis. (January 1989 - April 1989). Instructed a 4 unit upper division course in vertebrate physiological ecology within the Dept. of Wildlife & Fishery Biology. Responsible for independent preparation of all materials for lectures, handouts, and tests.

Teaching Assistant, University of California - Davis. (September 1988 - March 1990). Taught laboratory sections for mammalogy, botany, and general biology

Publications

Drost, C.A. and J.R. Petterson. 1999. Bat monitoring along the Colorado River through Grand Canyon National Park. Report to Arizona Game and Fish Heritage Division. 56 pp.

Sogge, M.K., T.T. Tibbitts, and J.R. Petterson. 1997. Status and breeding ecology of the Southwestern Willow Flycatcher in the Grand Canyon. Western Birds 28:142-157.

Petterson, J.R. and J.S. Spence. 1997. Avian community monitoring in the Grand Canyon - 1996. Final Report - BOR Glen Canyon Environmental Studies Program. 27 pp.

Petterson, J.R. and M.K. Sogge. 1996. Distribution and Breeding Productivity of the Southwestern Willow Flycatcher along the Colorado River in Grand Canyon - 1996 Summary Report. Grand Canyon National Park and National Biological Service Colorado Plateau Research Station. 30 pp.

Stevens, L., V. Meretsky, J. Petterson, F. Protiva, and J. Nagey. 1996. Impacts of a one-time test of beach habitat building flows from Glen Canyon Dam on Endangered Southwestern Willow Flycatchers in Grand Canyon, Arizona: Final Report - BOR Glen Canyon Environmental Studies Program. 54 pp.

Stevens, L.E., D.M. Kubly, V.J. Meretsky, and J. Petterson. 1995. The Ecology of Kanab Ambersnails at Vasey's Paradise, Grand Canyon, Arizona: 1995 Final Report - BOR Glen Canyon Environmental Studies Program. 34 pp.

Petterson, J.R. 1994. Wetland Bird Population Monitoring in Virgin Islands National Park, St. John, VI. National Park Service Report. 28 pp.

Petterson, J.R. 1992. Shorebird nesting ecology and monitoring in northwest Alaska. NRPP Project Report. National Park Service Technical Report, Kotzebue, Alaska, 35 pp.

Petterson, J.R. 1992. Yellow-bellied marmot predation on pikas. Canadian-Field Naturalist 106(1): 130-132.

Petterson, J.R. 1990. Influence of vegetation type and habitat structure on the distribution and ecology of North American mammals. Univ. Calif. Press Laboratory Manual. 130 pp.

Petterson, J.R. 1983. An auto-error correcting, auto-ranging analog data acquisition system. Data Communications 12: 84-94.

Petterson, J.R. 1983. Use of fiberoptic transmitters and receivers in high speed data applications. Photonics Spectra 16: 45-51.

Professional Affiliations

American Society of Mammalogists
American Ornithological Society
Ecological Society of America
The Wildlife Society
Cooper Ornithological Society
The Wildlife Society

RÉSUMÉ

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Education:

- B.S. University of California, Davis, 1983 (Botany)
- M.Sc. University of British Columbia, 1986 (Botany)
- Ph.D. University of Nebraska-Lincoln, 1989 (Biological Sciences/Botany)

Current Positions:

- Proprietor/Botanist, Nothing But Northwest Natives & Robson Botanical Consultants
- Adjunct Assistant Professor, Department of Natural Resource Sciences, Washington State University, Pullman. (presently teaching at Vancouver branch campus)

Employment Background, Research and Technical:

- **Robson Botanical Consultants**. Surveying and taxonomic identification of rare plants, wetland plants and exotic species for, EIS rare plant clearances, wetlands delineation, plant community quantification. Data collection, analysis, interpretation and reporting for communities or species of special interest Landscaping and re-vegetation recommendations and designs for riparian, wetland or upland restoration projects. Clients: Resources Northwest Consultants (rare vascular plant, bryophyte and lichen surveys adjacent to OR Hwy. 35 and Hwy. 26 on the Mt. Hood N.F., 2000 - present), Dames & Moore (rare plant surveys for proposed route of Cascade pipeline from east slope Cascades to Tri-Cities, 1996-1997), Environmental Technology Consultants (identification of wetlands plants and vegetation analysis for wetlands delineations, 1997-present), Nez Perce Tribe/US Dept. of Energy for the Inter-Tribal Restoration Team/EMSL Project (consulting on native plant propagation, salvage and restoration; analysis and interpretation of plant survival data collected from cemetery restoration project and propagation methods in the nursery. Landscape designs incorporating native plants and survey/ inventory of existing vegetation also available for homeowners. Robson Botanical Consultants & Nothing But Northwest Natives is a certified Women's Business Enterprise and Disadvantaged Business Enterprise in Washington (certification #: D2F6115128) and Oregon (certification #: 1214).

- **Nothing But Northwest Natives Nursery** (opened July 1998). We offer perennials, trees, shrubs, wetland plants, plants for birds and butterflies, erosion control and difficult gardening situations (wet

areas, dry shade, etc.). Retail/wholesale nursery, open Thurs. - Sun., 10:00 - 6:00. (By appointment August, Nov. - Feb.)

- **Watershed Stewardship Program, WSU Cooperative Extension, Clark Co**. (1999-2000). Developed new program to educate adult volunteers on factors impacting watershed health and practical solutions for protection and restoration. Organized 10 week, day-long training sessions that included workshops and seminars presented by experts in various fields. Projects include developing a Watershed Stewardship web site, demonstrations and displays.

- **Inter-Tribal Restoration Team & Native Plant Nursery**, Richland, WA (administered by Confederated Tribes of the Umatilla Indian Reservation & Nez Perce Tribe); Consulting Botanist (1994-1995) Assisted the Inter-Tribal Restoration Team & Native Plant Nursery (members included the Nez Perce Tribe of Idaho, Confederated Tribes of the Umatilla Indian Reservation, Wanapum People and Yakama Indian Nation) with the re-vegetation of a disturbed cemetery site near the Hanford Nuclear Reservation. Included the development of a temporary native plant nursery at WSU Tri-City campus, propagation of shrub-steppe species. Attempt to replace much original diversity reflected in successful cultivation of almost 40 native species,

- **Yakama Indian Nation, Environmental Restoration/Waste Mgmt. Program**, Botanist (1993-1994) Surveying, monitoring and mapping of rare plants and species of cultural importance, and assessing sensitive habitats, such as wetlands. Many areas are relatively pristine due to five decades of strictly controlled access, providing excellent baseline data for future restoration; developed a computerized botanical/ethnobotanical data base; assisted other Yakama Nation programs with the of draft EIS's (System Operations Review for the Columbia River, the Yakima Training Center expansion); workshops for the Tribe's summer camp education programs for children; assisted Yakama Nation Museum with ethnobotanical displays.

- **US Forest Service, PNW Research Station**, Forestry Sciences Lab, Wenatchee, WA; Post-Doctoral Research Botanist (1990-1992). Established research programs to study the growth, reproduction, ecology and systematics of rare species of vascular plants; organizer in starting the Rare Plant Consortium. Monitoring and greenhouse studies established for 14 rare endemic and disjunct species on several National Forests in the Pacific Northwest, in collaboration with many of the Consortium participants. Identified plants for various projects at the Wenatchee Lab; consulted on experimental and statistical methodology.

- **Rare Plant Consortium**, co-founder & secretary (1991-1994). Invited new members, organized meetings, kept participants informed of new developments and activities related to rare plant issues. In 1990 the Consortium was initiated as a network for those interested in rare plant biology and conservation, and grew to include 81 member organizations representing six nations.

Employment Background, Teaching - courses taught at Wash. St. Univ. Tri-Cities & Vancouver branch campuses (1993-present):

- **Botany 332, Systematic Botany**. A survey of vascular plants of the Pacific Northwest; principles of systematics, taxonomy & nomenclature; experience in the use of technical dichotomous keys.

- **Botany 410/510, Vascular Plant Anatomy**. Structures and functions of cells, tissues and organs of vascular plants, reproductive and vegetative; comparative morphology of major plant groups.
- **Botany 463/563, Field Ecology**. Quantifying natural vegetation in a variety of Pacific Northwest habitats; systematic & random sampling methods, data collection, analysis of vegetation and related abiotic variables; uses of different analytical approaches (frequencies, clustering, principal components, etc.); interpretation and description of results.
- **Natural Resource Sciences 301 & 302, Forest & Range Plant Resources I & II**. Taxonomy and applied ecology of native and exotic forest and range plant species of the Pacific Northwest; plant communities and relationships to geographic features and climate; overview of plant morphology/anatomy; experience in the use of technical dichotomous keys. Web site development.
- **Natural Resource Sciences 303, Conservation of Natural Resources**. Consideration of resource issues, focusing on both renewable (forests, range, wildlife, etc.) and non-renewable (soil, minerals, fossil fuel, etc.) resources. Human populations, resource consumption and pollution, and sustainable alternatives to destructive activities are central themes.
- **Natural Resource Sciences 417, Special Topic: Assessment of PNW Plant Communities**. Quantification and comparison of natural vegetation and relative disturbance, invasions of exotic species; understanding needs of future restoration projects by examining different plant communities and levels of human alteration.
- **Natural Resource Sciences 419/519, Special Topic: Restoration/Riparian Restoration**. Restoration of native vegetation on the WSU branch campuses, including eastern shrub-steppe and riparian areas west of the Cascades. Plant propagation; data collection on mortality rates, growth rates, reproductive output and herbivore damage; comparison of species in pristine, disturbed and restored sites; analysis and interpretation and reporting of results.
- **Natural Resource Sciences 450/550, Conservation Biology**. Covers a variety of conservation issues, especially of the Pacific Northwest; applied ecology, genetics and demographics in conservation; rare species; management strategies; diversity and fragmentation; economic, political, ethical and legal issues; preserves; case studies.
- **Natural Resource Sciences 353, Range Plant Identification**. Focus on identification of plant species (especially grasses) of greatest wildlife and range value in the Western states, emphasis on native and alien plants of the Columbia Basin.

Selected Publications:

Maze, J., K. Robson & S. Banerjee. 2000. Studies into the abstract properties of individuals. IV. Emergence in different aged needle primordia of Douglas fir. BioSystems. 56:43-53.

Maze, J. & K. Robson. 1996. A new species of *Achnatherum* (*Oryzopsis*) from Oregon. Madroño, 43(3):393-403.

Robson, K.A. 1996. Propagating shrub-steppe herbaceous dicots in south-central Washington. Restoration & Mgmt. Notes. 14(1):76-77.

Robson, K. and J. Maze. 1995. A comparison of rare and common grasses of the Stipeae. I. Greenhouse studies of growth and variation in four species from parapatric populations. Int. J. Plant Sci. 156(4):530-541.

Robson, K.A., J. Maze, R.K. Scagel and S. Banerjee. 1993. Ontogeny, phylogeny and intraspecific variation in North American *Abies* Mill. (*Pinaceae*): an empirical approach to organization and evolution. Taxon 42(1):17-34.

Maze, J. and K. Robson. 1993. In defense of aesthetics. Lasthenia, a publication of the U.C. Davis Herbarium, Summer.

Maze, J. and K. Robson. 1991. Tracking changes in northern and southern distributional limits of plant species in interior British Columbia and Washington. NW Environ. J. 7:351-352.

Robson, K.A. and S.P. McCormick. 1988. 6-methoxyflavonoids from *Balsamorhiza* section *Artorhiza*. Biochem. Syst. and Ecol. 16:411-412.

McCormick, S.P., K.A. Robson, J. Maze and B.A. Bohm. 1987. Flavonoids from *Wyethia* section *Agnorhiza*. Phytochemistry. 26:2421-2422.

Government Reports:

Robson, K.A. 1992. A comparative study of the rare Wenatchee larkspur (*Delphinium viridescens*) and its sympatric relative, Western monkshood (*Aconitum columbianum*). USDA-USFS, Pacific Northwest Research Station, Portland.

Robson, K.A. 1992. Reproductive constraints and seedling recruitment in the endangered showy stickseed (*Hackelia venusta*). USDA-USFS, Pacific Northwest Research Station, Portland.

References: (letters from the following are available upon request)

Dr. William W. Barker, Professor Emeritus, Department of Biology, Central Washington University, Ellensburg. (509) 962-2202 (home).

Dr. Cyril V. Finnegan, Dean Emeritus of Science, University of British Columbia, Vancouver, B.C. V6T 1Z4, Canada. (604) 822-3366 (office) or (604) 222-2459 (home).

Dr. Jack Maze, Professor Emeritus, Department of Botany, University of British Columbia, Vancouver, B.C. V6T 1Z4, Canada. (604) 822-6554 (office) or (604) 732-8381 (home).

Dr. William H. Rickard, Research Ecologist, Retired, Battelle PNW Laboratory & Washington State University, Tri-Cities, Richland, WA. (509) 946-9195 (home).

Curriculum Vitae

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Education

1995 Ph.D. Ecosystem Science and Conservation. College of Forest Resources, University of Washington, Seattle, Washington.

1978 M.F.S. School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut.

1975. B.S. Biology. Northeastern University, Boston, Massachusetts.

Professional Experience

1998- present Science Advisor, North Cascades National Park Service Complex.

1984-1998 Botanist, Mount Rainier National Park. Responsibilities: developed and implemented the park's first plant ecology program including vegetation and soil restoration, rare plant monitoring, exotic plant inventories and control, human impacts surveys in wilderness areas, greenhouse propagation of native plants, long-term monitoring of alpine plant communities, and monitoring of short-term impacts to plant communities. Initiated first GIS Program for the park.

1982- 1984 Botanist, Everglades National Park. Responsibilities: fire effects monitoring, development and implementation of the Exotic Plant control program, and fire behavior monitoring.

1979- 1982 Ecologist, South Florida Research Station, Everglades National Park. Responsibilities: establishment and monitoring of fire research program in Big Cypress National Preserve.

Publications

Campbell, S.; Smith, G.; Temple, P.; Pronos, J.; Rochefort, R.; and Andersen, C. 2000. Monitoring for Ozone Injury in West Coast (Oregon, Washington, California) Forests in 1998. U. S. Dept. of Agriculture, Forest Service, Pacific northwest research station, General Technical Report PNW-GTR-495, 19 pp.

Rochefort, R. M. and Peterson, D. L. 2000. Genetic and morphologic variation in Phyllodoce empetriformis and P. glanduliflora (Ericaceae) in Mount Rainier National Park, Washington. Canadian Journal of Botany (in press).

Rochefort, R. M. and Swinney, D. D. 2000. Human impact survey in Mount Rainier National Park: past, present and future. *In*: Cole, D. N.; S. F. McColl; W. T. Borrie; and J. O'Laughlin (comps.), Wilderness Science in a Time of Change Conference – Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Research Station. pp. 165-171.

Rochefort. R. M.; Albright, M.; and Milliren, P. 1998. The propagation of three greenhouse programs in the Pacific Northwest. Park Science 19(1) 17-19.

Rochefort, R. M. and Peterson, D. L. 1996. Temporal and spatial distribution of trees in subalpine meadows of Mount Rainier National Park. Arctic and Alpine Research 28(1): 52-59

Rochefort, R. M. 1995. Whitebark pine blister rust survey, Mount Rainier National Park, 1994. Nutcracker Notes 6: 2-3.

Rochefort, R. M.; Little, R. L.; Woodward, A.; and Peterson, D.L. 1994. Changes in sub-alpine tree distribution in western North America: a review of climatic and other causal factors. The Holocene 4(1): 89-100.

Rochefort, R. M., and Gibbons, S. T. 1993. Impact monitoring and restoration in Mount Rainier National Park. Park Science 13(1): 29 - 30.

Rochefort, R. M., and Peterson, D. L. 1993. Genetic diversity and protection of alpine heather communities in Mount Rainier National Park. Park Science 13(2): 28-29.

Rochefort, R.M. and Peterson, D.L. 1992. Genetic resource management units: managing biodiversity in National Parks. *In*: Brown, W.E. and Veirs, Jr., S. D. (eds.), Partners in Stewardship: Seventh Conference on Research and Resource Management in Parks and on Public Lands. Hancock, Michigan: The George Wright Society, Inc. pp 149 - 153.

Rochefort, R. M. and Gibbons, S. T. 1992. Mending the meadow: High-altitude meadow restoration in Mount Rainier National Park. Restoration and Management Notes 10(2): 120-126.

Rochefort, R. M. and Peterson, D. L. 1991. Tree establishment in subalpine meadows of Mount Rainier National Park. The Northwest Environmental Journal 7(2): 354-355.

Rochefort, R. M. 1989. Paradise Meadow Plan. Mount Rainier National Park.

Rochefort, R. M. 1990. Restoration Handbook, Mount Rainier National Park.

Rochefort, R. M. and Bivin, M. M. 1988. Vegetation monitoring of a subalpine oil spill. Park Science 8(2):4.

Doren, R. F. and Rochefort, R. M. 1984. Summary of fires in Everglades National Park and Big Cypress National Preserve, 1981. Report SFRC-84/01, South Florida Research Center, Homestead, Florida.

Rochefort, R. M. and Doren, R. F. 1983. Everglades National Park: Fire. IN: Proceedings of the Wilderness Fire Symposium, USDA Forest Service, Missoula, MT.

Maynard, W.R.; Taylor, D. L.; and Rochefort, R. M. 1981. Virgin subtropical slash pine forest. American Birds 35(1):70.

Samora, B.A., R. M. Rochefort, D. Swinney. In prep. Mount Rainier National Park Wetlands Inventories Draft Final Report Mount Rainier National Park. Ashford, Washington.

Taylor, D. L. and Rochefort, R. M. 1981. Fire in Big Cypress National Preserve, Florida. USDA Forest Service, Fire Management Notes Spring: 15 - 18.

Curriculum Vitae

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Education

1974	A.S. ,School of Natural Resources, Columbia College, Columbia, California
1975-78	School of Natural Resources, Humboldt State University, Arcata, California.
1981-78	B.S. Institute of Natural and Environmental Resources, University of New Hampshire, Durham, New Hampshire
1983	Graduate Courses (Wetland Ecology, Coastal Ecology), Worcester State University, Worcester, Massachusetts
1984-85	*Natural Resources Management Graduate Program, Slippery Rock University, Slippery Rock, Pennsylvania*
1992	Graduate Course (Landscape Ecology), University of Washington, Seattle.

Professional Experience

1988- present	Biologist, Mount Rainier National Park. Responsibilities: Manage the park's Aquatic, Air Resources, Geologic Resources and Social Science Programs. Developed and implemented the park's first aquatic ecology program including amphibian, fish, invertebrate and wetland surveys. Initiated inventories and long-term monitoring of park lakes and streams. Manage and supervise numerous projects involving aquatic, air and geologic resources including the parkwide aquatic amphibian surveys. Initiated long-term monitoring of stream water quality of representative sites. Initiated first comprehensive air resources management program that focuses on air quality related values, such as aquatic resources, that may be affected by air pollutants. Developed the park's first Wilderness management program.
1982-1988	Resource Management Specialist, Cape Cod National Seashore. Responsibilities: Developed and implemented the park's first Resource Management Program. Developed and implemented programs involving inventories and management of wildlife, freshwater resources (lakes, streams, fish, amphibians, invertebrates), marine and estuarine resources, air quality, coastal geology, and plant ecology. Managed programs involving these resources as well as projects involving coastal dune restoration, integrated pest management, and prescribed fire research.

1980- 1982 Environmental Specialist, National Park Service, North Atlantic Regional Office. Responsibilities: Reviewed Environmental Impact Statements, Federal Energy Regulatory Commission Permits, and other environmental documents for their effects on national park system units in Maine, New Hampshire, Massachusetts, New York, Connecticut and Rhode Island. Prepared environmental documents for park and regional related projects. Assisted in preparation of the first Water Resources Management Plan and the Off Road Vehicle Management Plan for Cape Cod National Seashore.

1975-1979 Park Ranger, Yosemite National Park.

Publications

Samora, B.A., B.J. Brokes, C.D. McIntire, and G.L. Larson. In prep Inventory of Amphibians in Aquatic Habitats of Mount Rainier National Park, 1996-1999. Mount Rainier National Park. Ashford, Washington.

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Curriculum Vitae

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Selected Recent Publications:

O'Dell, T. E., J. M. Trappe, N. S. Weber and E. G. Schreiner. 1992. Fungal diversity in Olympic National Park. Northwest Environmental Journal. 8:170-172.

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Appendix 6. Listed Plant Species and General Locations in North Cascades National Park Service Complex.

Scientific Name	State Status	Collection Locations	Date
Botrychium pinnatum	S	Triplet Lake	1984
Carex buxbaumii	S	Ridley Lake	1986
		Big Beaver Valley	1986
Carex macrochaeta	S	Stetattle RNA	1987
Carex magellanica ssp. *irrigua*	S	Big Beaver Valley	1986
Carex pluriflora	S	Big Beaver Valley	1988
Carex saxatilis var. *major*	S	Triplet Lake	1984
		Willow Lake	1988
Epipactis gigantea	S	Stehekin (just south of landing)	1969, 1990
Erigeron salishii	S	Rennie Peak (on bound. w/USFS)	1996
Githopsis specularioides	S	Stehekin (2.5 mi south)	1970
Impatiens aurellia	R2	SR 20, NE of Bacon Creek	1976
Loiseleuria procumbens	S	Trapper Peak	1963
Lycopodiella inundata	S	Big Beaver Valley	1986
Lycopodium dendroideum	S	Big Beaver Valley	1986
Pinguicula vulgaris	R1	Thunder Arm	1970
		Silver Lake RNA	1980
		Big Beaver Valley	1988
		SR20/Diablo Lake-Ross Dam Rd	2000
Platanthera obtusata	S	Newhalem Creek Campground	1991
Poa arctica ssp. *arctica*	S	Silver Lake RNA	1980
		Boston Basin	1982
Saxifraga rivularis	S	Boulder Butte, Lake Juanita	1984

bold typeface indicates records ≥ 25 years old

Appendix 6. Listed Plant Species Possible in North Cascades National Park (collection locations are outside the park) (continued).

Scientific Name	State Status	Collection Locations	Date
Agoseris elata	S	Hart's Pass	1972
Astragalus arrectus	S		
Aster sibiricus var. *meritus*	S	near Glacier, WA	1989
Botrychium lanceolatum	S	near Glacier, WA	1989
Botrychium lunaria	S	near Loomis, WA	1987
Botrychium minganense	R2	near Granite Falls, WA	1988
Botrychium simplex var. *simplex*	S	near Loomis, WA	1987
Campanula lasiocarpa	S	near Darrington, WA	1989
Carex atrosquama	S		
Carex comosa	S	near Winthrop, WA	1972
Carex heteroneura	S		
Carex norvegica	S		
Carex proposita	S	near Berne, WA	1991
Carex scirpoidea var. *scripoidea*	S	Crater Mountain	1971
Carex scopulorum var. *prionophylla*	Watch	Rock Mountain	1991
Carex stylosa	S	near Silverton, WA	1990
Cicuta bulbifera	S	near Leavenworth, WA	1988
Cimicifuga elata	T *	Sumas Mountain	1990
Coptis asplenifolia	S	Lake 22	1971
Corydalis aurea	R1		
Cryptogramma stelleri	S		
Cypripedium fascisulatum	T *	Blewett Pass	1989
Cypripedium parviflorum	E	near Twisp, WA (C. calceolus var. parv.)	1979
Dodecatheon pulchellum var. *watsonnii*	Watch		
Draba aurea	S	Hart's Pass	1972

Appendix 6. Listed Plant Species Possible in North Cascades National Park (collection locations are outside the park) (continued).

Scientific Name	State Status	Collection Locations	Date
Eleocharis atropurpurea	Extirpated?		
Erigeron humilis	Review		
Eritrichium nanum var. *elongatum*	S	Hoodoo Pass	1971
Erythronium revolutum	S		
Fritillaria camschatcensis	S		
Galium kamtschaticum	S	near Silverton, WA	1990
Gentiana glauca	S	near Loomis, WA	1972
Hackelia hispida var. *disjuncta*	S		
Hypericum majus	S	near Concrete, WA	1972
Limosella acaulis	Watch	Antilon Lake	1982
Listera borealis	S		
Mimulus pulsiferae	S		
Mimulus suksdorfii	S		
Mimulus washingtonensis	Review		
Orthocarpus bracteosus	T		
Parnassia kotzebuei var. *kotzebuei*	S		
Pellaea brachyptera	S	Prince Creek near Lucerne	1971 1987
Penstemon erianthus var. *whitedii*	R1	near Chelan, WA	1989
Pleuricospora fimbriolata	Watch		
Polemonium viscosum	S	near Winthrop, WA	1989
Potamogeton obtusifolius	S		
Potentilla diversifolia var. *perdissecta*	S	near Loomis, WA	1972, 1987
Ranunculus cooleyae	S		
Salix tweedyi	S	near Conconully, WA	1988
Salix vestita var. *erecta*	Extirpated?		

Appendix 6. Listed Plant Species Possible in North Cascades National Park (collection locations are outside the park) (continued).

Scientific Name	State Status	Collection Locations	Date
Sanicula marlandica	S	Chewack River Valley	1983
Saxifraga intergrifolia var. *apetala*	Watch	Hoodoo Pass	1971
Silene seelyi	T *		
Spiranthes porrifolia	S	McMillan Park	1970
Swertia perennis	R1		
Utricularia minor	R1	near Darrington, WA	1977

*also a federal species of concern

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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